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AN EXAMINATION OF VARIABLES WHICH INFLUENCE HIGH SCHOOL STUDENTS TO ENROLL IN AN UNDERGRADUATE ENGINEERING OR PHYSICAL SCIENCE MAJOR

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Educational Leadership

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by
Christopher H. Porter
December 2011

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ABSTRACT

The purpose of this study was to examine the variables which influence a high school student to enroll in an engineering discipline versus a physical science discipline. Data was collected utilizing the High School Activities, Characteristics, and Influences Survey, which was administered to students who were freshmen in an engineering or physical science major at an institution in the Southeastern United States. A total of 413 students participated in the survey.

Collected data were analyzed using descriptive statistics, two-sample Wilcoxon tests, and binomial logistic regression techniques. A total of 29 variables were deemed significant between the general engineering and physical science students. The 29 significant variables were further analyzed to see which have an independent impact on a student to enroll in an undergraduate engineering program, as opposed to an undergraduate physical science program. Four statistically significant variables were found to have an impact on a student's decision to enroll in a engineering undergraduate program versus a physical science program: father's influence, participation in Project Lead the Way, and the subjects of mathematics and physics.

Recommendations for theory, policy, and practice were discussed based on the results of the study. This study presented suggestions for developing ways to attract, educate, and move future engineers into the workforce.

DEDICATION

I would like to dedicate this work to my wonderful wife, Stacy Draisen Porter. Thank you so much for encouraging me to pursue this degree and keeping me motivated when I felt like quitting. I promise to clean off the dining room table once I graduate.

ACKNOWLEDGEMENTS

There are numerous people who I would like to thank for their support, prior to, and during this project. In no particular order… thanks to mom, dad, Monique, Robert, Frank, Sam, Beth, Steve, Christine, Jessica, Randy, my committee, Peter, Ellen, Barry, all of my professors from the past 20 years, and anyone else who encouraged me along the way.

Special thanks to Mike B., Mike G., Kellye, Jason, Helen, Yoruba, Helen, Carrie, and all of the other doctoral students I met throughout the program. You guys made each class less intimidating and worth going to every night - best of luck to each of you in the future. The only way to make it through this program is with a group of friends you can rely on!

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CHAPTER 1

NATURE AND SCOPE OF THE STUDY

From making machines more efficient, materials stronger and lighter, to inventing live-saving technology, engineers do it all. Baine (2003) defined engineers as those who "work to improve the quality of life and to make life more efficient and comfortable" (p. 18). The U.S. Department of Labor (2007), on its Bureau of Labor and Statistics (BLS) website, stated: "Engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is the link between scientific discoveries and the commercial applications that meet societal and consumer needs." Engineers incorporate many different skills in their profession, Baine (2009) stated:

> Engineers are modern day superheroes and as such, must be ready for anything in an increasingly technology-dependent world. Using math, science, knowledge, and ingenuity in practical ways, they design, invent, create and concoct the most remarkable physical achievements and significant advancements in the quality of life known to humanity. They are some of the most creative people on earth. Engineers make our lives better, easier, cheaper, more efficient and more fun by solving everyday problems (p. 24).

There are many different types of engineering specialties; the Federal Government's Standard Occupational Classification (n.d.) system identifies seventeen different types of engineering specialties. These areas include: Aerospace, Agricultural, Biomedical, Chemical, Civil, Computer Hardware, Electrical, Electronics, Environmental, Health and Safety, Industrial, Marine, Materials, Mechanical, Mining and Geological, Nuclear, and Petroleum engineers.

A bachelor's degree in engineering is required for nearly all entry-level engineering positions (BLS, 2007), however, some graduates in science or mathematics disciplines may qualify for similar positions. The Accreditation Board for Engineering and Technology (ABET), Inc. is the recognized accreditor of degree-granting postsecondary programs in applied science, computing, engineering, and technology. There are approximately 1,850 ABET accredited institutions in the United States, with a total of 1,874 world-wide (K. Cryer, personal communication, June 24, 2009). There are also 30 engineering graduate programs that hold ABET accreditation. The BLS (2007) web site reported that "ABET accreditation is based on a program's faculty, curriculum, and facilities; the achievement of a program's students; program improvements; and institutional commitment to specific principles of quality and ethics."

A comprehensive survey conducted by the National Science Foundation (2007) indicated that the number of students graduating with bachelor's degrees in engineering has increased every year since 2000. While the number of students graduating with bachelor's degrees in non-science and non-engineering fields increased by 19% between 2000 and 2007, there was only an increase of 13% during the same time period of engineering graduates. Table 1.1 lists the number of bachelor's degrees awarded among all fields, science and engineering, engineering, and non-science and non-engineering between 2000 and 2007 in the United States.

Table 1.1

Bachelor's Degrees Awarded 2000-2007in the United States

Year	All Fields	S&E	Engineering	Non- S&E
2000	1,254,618	398,602	59,487	856,016
2001	1,260,308	400,435	59,214	859,873
2002	1,308,970	415,983	60,605	892,987
2003	1,365,694	442,755	63,789	922,939
2004	1,417,421	458,658	64,680	958,763
2005	1,465,401	470,214	66,152	986,187
2006	1,502,922	478,858	68,227	1,024,064
2007	1,541,704	485,772	68,274	1,055,932

Students wishing to pursue engineering degrees must prepare themselves by taking a rigorous set of courses while in high school. According to the BLS (2007), a student's curriculum should include four units of mathematics (algebra, geometry, trigonometry, and calculus), three units of science (chemistry, biology, and physics), and computer programming. In addition to technical classes, students will also need courses in English, humanities, and social sciences.

In fall 2005 and fall 2006, the National Science Board (2007) hosted workshops focusing on the state of engineering education. The workshop attendees included representatives from industry, government agencies, engineering societies, and leading engineering schools. The participants concluded:

> In addition to analytical skills, which are well provided by the current education system, companies want engineers with passion, some systems thinking, an ability to work in multicultural environments, and ability to understand the business context of engineering, interdisciplinary skills, communications skills, leadership skills, and ability to adapt to changing conditions, and an eagerness for lifelong learning (National Science Board, 2007, p. 2).

The job outlook for engineers is good when compared to other fields, with some engineering specialties seeing better growth than others (BLS, 2007). The BLS (2007) reported that the number of engineering graduates should be in balance with the number of job openings between 2006 and 2016; additionally, “openings from job growth, many openings will be created by the need to replace current engineers who retire; transfer to management, sales, or other occupations; or leave engineering for other reasons.” The National Employment Matrix (2007) predicted an 11% increase in the overall number of engineering positions from 2006 to 2016; some of these engineering specialties, such as Biomedical engineers and Environmental engineers, can expect projected increases of 21% and 25%, respectively.

The 2009 Pay Scale College Salary Report, posted by Pay Scale, Inc. (2010) (Table 1.2), published the best undergraduate degrees by salary. The posting showed salaries for students pursuing bachelor’s degrees in various fields. Of the top ten college majors that lead to high salaries, nine were in science and engineering disciplines.

Table 1.2

Top 10 College Majors That Lead to High Salaries

Major	Starting Median Salary	Mid-Career Median Salary
Aerospace Engineering	$59,600	$109,000
Chemical Engineering	$65,700	$107,000
Computer Engineering	$61,700	$105,000
Electrical Engineering	$60,200	$102,000
Economics	$50,200	$101,000
Physics	$51,100	$98,800
Mechanical Engineering	$58,900	$98,300
Computer Science	$56,400	$97,400
Industrial Engineering	$57,100	$95,000
Environmental Engineering	$53,400	$94,500

Statement of the Problem

While the employment outlook for engineering graduates is encouraging, industry, employers, and government experts have recognized there is a need for an increase in qualified engineers. An article posted June 30, 2009 on the Forbes web site opened with the following statement: "For the second year in a row, engineer is the hardest job to fill in America" (Weiss, 2009). Larry Jacobson, executive director of the National Society of Professional Engineers, was quoted in the article saying "We have whole generations of people loving liberal arts, not going into science and math" (2009). Regarding current engineers entering retirement, Jacobson said "Companies are looking to replace more than half of their engineers over the next eight years, because baby boomers are retiring." If engineering schools in the United States were somehow able to fill every seat, they would still only train 75,000 engineers annually (Jacobson as cited in Forbes, 2009). Freeman, Jaeger, and Whalen (2009) cited a BLS outlook that "employment looks promising for engineering majors with the demand for new technology and innovation, and a labor pool that's aging as many workers approach retirement" (p. 4). In addition, the NSF reported that "engineering is not attracting enough people to the field, and often is not attracting the diversity of backgrounds needed. A central issue is the way that engineering is perceived by prospective students, teachers, guidance counselors, and parents" (National Science Board, 2007). How do we encourage more high school students to enter undergraduate engineering majors?

Purpose of the Study

The purpose of this study is to identify which variables have a significant impact on a high school student's decision to pursue an undergraduate engineering degree. More specifically, utilizing Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory, the researcher examined influential variables in the categories of interests, outcome expectations, self-efficacy, social barriers, and social supports. The researcher administered a survey to approximately 1,075 first-time college freshmen engineering and physical science students at an institution in the Southeastern United States. Of these

1,075 students, approximately 911 were first-semester freshmen engineering students and the other 164 were first-semester freshmen enrolled in a physical science major.

Research Questions

This study investigated the characteristics of college freshmen who enrolled in an engineering discipline for their first year of college. The overarching research question for the study is: What characteristics of high school students influenced them to enroll in engineering their first year in college? The following specific research questions guided the study:

1. What are the demographic characteristics of students entering a freshmen engineering or physical science program?
2. Which variables have a significant influence on a student’s decision to pursue an engineering degree versus physical science degree in college?

Definitions and Terms

The following are definitions, terms, and/or classifications used in the study.

- *Goals* – the intention to engage in a particular activity or to produce a particular outcome (Bandura, 1986)
- *Interests* – people’s pattern of likes, dislikes, and indifferences regarding different activities (Lent & Brown, 2006)
- *Outcome Expectations* – beliefs about the consequences or outcomes of performing certain behaviors (Lent & Brown, 2006)

- *S&E* – Science and Engineering
- *Self-efficacy* – one's judgment of their abilities to attain designated types of performances
- *SEM* – Science, Engineering, and Mathematics
- *Social Barriers* – obstacles to pursuing one's goals (ex: being a first-generation college student, living in a low-income household)
- *Social Supports* – facilitative influences to pursuing one's goals(ex: supportive parents and friends, access to knowledge and experts)
- *STEM* – Science, Technology, Engineering, and Mathematics
- *STEMM* – Science, Technology, Engineering, Mathematics, and Medicine

Theoretical Framework

The theoretical framework for the study is based on Lent's et al. (1994) Social Cognitive Career Theory (SCCT). SCCT "is concerned with the interplay between a variety of personal, environmental and behavioral variables that are assumed to give rise to people's academic and career-related interests, choices, and performance outcomes" (Lent et al., 2005, p. 84). The SCCT framework "emphasizes three social cognitive mechanisms that seem particularly relevant to career development: (a) self-efficacy beliefs, (b) outcome expectations, and (c) goal representations" (Lent et al., 1994, p. 83).

According to Bandura (1989), self-efficacy refers to "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances." Lent viewed self-efficacy as "not a passive, static trait, but rather is seen as a dynamic set of self-beliefs that are specific to particular performance domains and that interact complexly with other person, behaviors, and contextual factors" (p. 83). Bandura (1999) stated that human ability is a dynamic attribute, and that competent performance at a challenging task generally requires both competent skills and a strong sense of efficacy to deploy one's resources effectively.

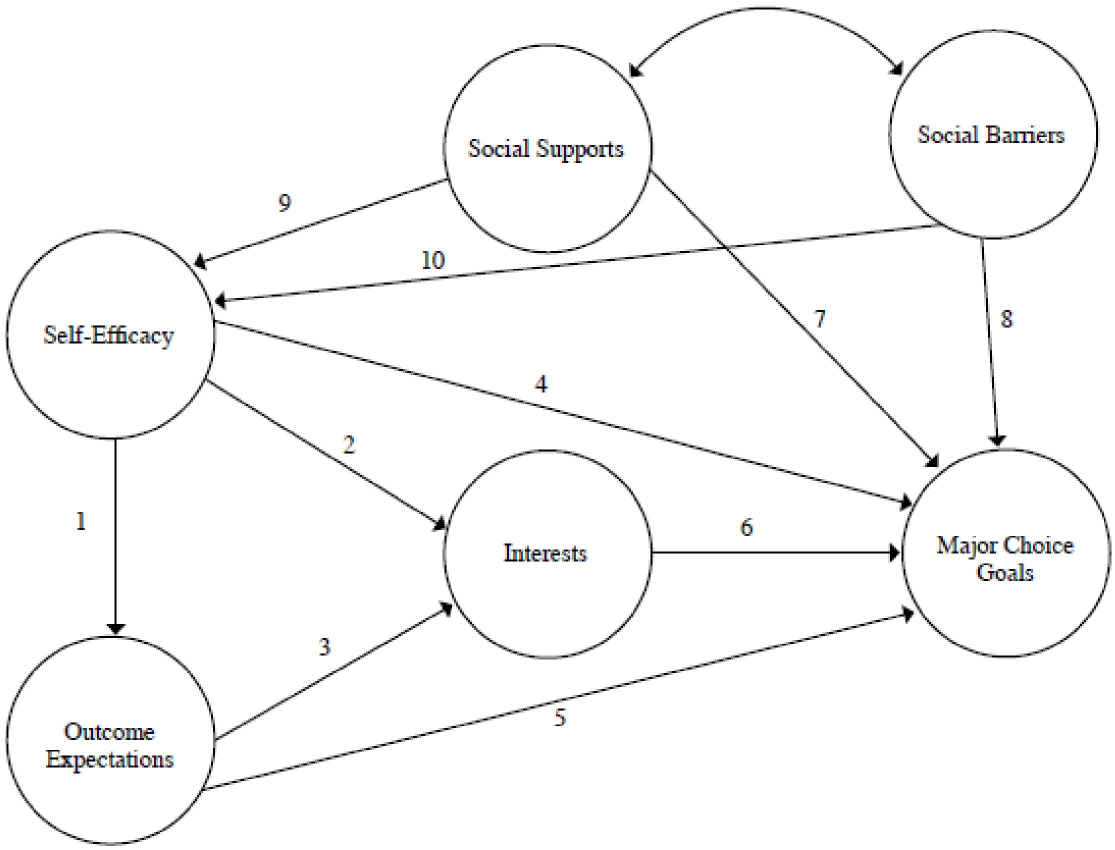
Outcome expectations involve the imagined consequences of performing particular behaviors ("ex: If I do this, what will happen?") (Lent et al., 1994). Outcome expectations can include anticipation of physical (ex: money), social (ex: approval), and self-evaluative (ex: self-satisfaction) actions (Bandura, 1986).

According to Lent at al. (1994), goals play an important part in behavior. Setting goals allows people to organize and guide their behavior, to sustain it over long periods of time even in the absence of external reinforcement, and to increase the likelihood that desired outcomes will be attained (Lent et al., 1994).

Lent et al. (2005) visualized their theory in Figure 1.1. The path model depicts SCCT's predictors of academic interests and choice goals.

Figure 1.1

Lent's et al. (2005) Path Model Depicting Social Cognitive Career Theory's Predictors of Academic Interests and Choice Goals



Lent et al. (2005) made several predictions that are consistent with SCCT's basic interest and choice models. SCCT posits that self-efficacy serves as a partial source of outcome expectations, with higher self-efficacy promoting more positive outcome beliefs (see Figure 1.1, Path 1). Second, SCCT holds that interests arise in activity domains in which people believe they are (a) able to perform effectively and (b) likely to receive desired outcomes. Accordingly, self-efficacy (see Figure 1.1, Path 2) and outcome expectations (see Figure 1.1, Path 3) would each explain unique variance in interests. Third, SCCT hypothesizes that people aspire to enter fields in which they express interest, believe they have the requisite capabilities, and expect to achieve favorable outcomes. Self-efficacy (see Figure 1.1, Path 4), outcome expectations (see Figure 1.1, Path 5), and interests (see Figure 1.1, Path 6) would each predict choice goals. Because self-efficacy and outcome expectations are assumed in SCCT to promote choices partly through their linkage to interests, interests would partially mediate the relations of self-efficacy and outcome expectations to choice goals.

SCCT posits that supports and barriers relate to goals directly, whereas general social cognitive theory (Bandura, 1999, 2000) suggests that there are both direct and intervening paths (via self-efficacy) to goals (e.g., supports and barriers inform self-efficacy, which, in turn, relate to goals). Recent research has found more evidence favoring the indirect versus direct paths to choice outcomes (e.g. Lent et al., 2001; Lent, Brown, & Hackett, 1994). Lent et al. (2005) included both the direct (see Figure 1.1, Paths 7 and 8) and indirect paths (see Figure 1.1, Paths 9 and 10) in their model tests.

The Pennsylvania State University Cooperative Extension (2008) stated SCCT career choice is influenced by the beliefs the individual develops and refines through four major sources: a) personal performance accomplishments, b) vicarious learning, c) social persuasion and d) physiological states and reactions. How these aspects work together in the career development process is through a process in which an individual develops an expertise/ability for a particular endeavor and meets with success. This process reinforces one's self-efficacy or belief in future continued success in the use of this ability/expertise.

As a result, one is likely to develop goals that include continuing involvement in that activity/endeavor. Through an evolving process beginning in early childhood and continuing throughout adulthood, one narrows the scope to successful endeavors to focus on and form a career goal/choice. What is critical to the success of the process is the extent to which one views the endeavor/activity as one at which they are successful and offers valued compensation. The contextual factors come into play by influencing the individual's perception of the probability of success. If a person perceives few barriers the "likelihood of success reinforces the career choice, but if the barriers are viewed as significant, there is a weaker interest and choice actions" (Pennsylvania State University Cooperative Extension, 2008, p. 2).

Gibbons and Shoffner (2004) described SCCT as examination of "how career and academic interests mature, how career choices are developed, and how these choices are turned into action" (p. 93). Ojeda and Flores (2008) utilized SCCT in a 2008 study because of the theory's emphasis "on contextual variables in career development and its applicability with racial/ ethnic groups" (pp. 84-85). Nauta and Epperson's (2003) research concluded that the:

> SCCT framework may be a useful way to conceptualize the decision processes of young women who will at some future time be making decisions about whether to remain in the [Science, Mathematics, and Engineering] pipeline or switch to majors that are more gender traditional (p. 455).

Significance of the Study

The present study contributes to the body of research on the factors that influence high school students to select specific undergraduate majors in engineering and the physical sciences. Results from the study can aid business, industry, and educators in directing high school students to become future engineers. Additionally, results from the present study can aid educators and industry in developing policy and practice to attract, educate, and move students into the engineering fields.

Organization of the Study

The current study is organized into five chapters. The first chapter has presented an introduction about the field of engineering, the job outlook for the profession, and the need for additional engineers. Additionally, this chapter also contains the purpose of the study, research questions, theoretical framework, and the significance of the study.

Chapter two of the study contains a three-part review of the relevant literature. The three parts of the chapter include: the need for more engineers, characteristics of STEM students, and existing programs designed to increase interest in engineering and science.

The third chapter discusses the research methodology and design used in the study. The two research questions presented earlier provided for the chosen research design. Participants, instrumentation, variables, data collection, and data analysis will also be discussed.

Chapter four presents the findings from the study. The analyses of the findings are presented, along with descriptive statistics and other acquired data.

Chapter five includes a summary of the survey and the significant findings. The fifth chapter also includes: (a) review of relevant literature, (b) theoretical framework, (c) summary of findings, (d) discussion of findings, (e) conclusion, (f) limitations, (g) implications for theory, policy, and practice, and (h) suggestions for future research.

Chapter Summary

The purpose of this chapter was to discuss what engineers are and the qualities they need and possess. Additionally, Chapter One also focused on the number of bachelor’s degrees awarded in STEM and non-STEM disciplines, as well of the BLS outlook for STEM disciplines. The chapter also included an overview of the studies theoretical framework, Social Cognitive Career Theory, as well as purpose, research questions, definition of terms, significance, and organization of the study.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

The review of literature for this study focused on the need for more engineers, characteristics of Science, Technology, Engineering, and Mathematics (STEM) students, and existing programs designed to increase interest in engineering and science.

The Need for More Engineers

The National Science Foundation (NSF) (2004) stated that the number of retirements among U.S. workers in science and engineering "will increase dramatically over the next 20 years." The NSF (2003) reported there were approximately 1,554,800 engineers in the United States workforce: 1,382,500 were men, fewer than 80,000 were Hispanic, and fewer than 60,000 were Black. In 1998, the NSF found the under-representation of women and minorities in SEM fields was burdening the nation's capacity for economic growth. Over the past decade, numerous newspaper article articles, professional journals, trade magazines, and government reports have stated there will soon be a shortage of engineers. *Control Engineering* stated "engineers and scientists are in short supply, with 65% of manufactures reporting deficiencies – 18% severe and 47% moderate" (Control Engineering, 2005). IEEE, the professional association of electrical engineers, released a report that stated "about 45 percent of engineers at electric utilities are expected to retire or leave their jobs within five years, creating as many as 21,000 job openings" (IEEE, 2009). According to IEEE (2009), while more students are enrolling in power and energy-engineering courses, the increase will not meet the need. Cross (2001) found that current retirement patterns and increased need for employees with technical experience has led to a shortage of individuals to fill SME jobs.

The Voice over Internet Protocol (VoIP) is a growing industry that is in need of workers in IT support, program engineering, and customer support (Harris, 2008). As new types of VoIP services and applications are developed, additional software developers and engineers will be needed to respond to support the advancing technology. Along with the VoIP industry, there is a demand for engineers in other I.T. industries in the United States.

Anderson (2008) stated that there is a shortage of engineers who truly understand what embedded systems are. According to Anderson, embedded systems "can be characterized as any device in which you inherently know there must be a computer in there someplace, but you're just not sure where" (2008, online). True embedded systems developers must understand caches, instruction pipeline flushes, context switches, and memory management units (MMUs).

Merriman (2008) reported the oil industry was experiencing a shortage of engineers, which, in part, led to record high prices in the summer of 2008. The industry was suffering a shortage because skilled engineers opted for higher-paying positions in the 1980s and 1990s. Merriman (2008) stated that "graduates in the West have a lot more choices than they did 10 to 20 years ago, so compensation has to be such that it makes engineering careers in the oil business more attractive" (online). As demand for oil increases, the demand for skilled engineers will only increase, as the industry seeks to open additional oil reserves and refining capacity.

Earlier last decade the American Society of Civil Engineers (ASCE) released a document entitled: the *2005 Report Card for America's Infrastructure*. The report argued that the United States' "roads, bridges, drinking water systems, and other infrastructure components require substantial investment if they are to continue to meet the nation's needs" (Brown, 2005, p. 47). The report suggested a great need for civil engineers will be needed in the future. Brown (2005) stated there is a high market demand, and employers are scrambling to fill civil engineering positions in northern California. Additionally, recent governmental changes in Maryland have led to an increased workload for civil engineers in the areas of storm-water design and management (Brown, 2005).

The nuclear energy industry also suffered a shortage of engineers. Thomas (2008) stated:

> More recently, articles in the popular press have suggested the field may be entering a boom, and the American Nuclear Society has said there are three times as many jobs as there are job candidates. International nuclear agencies have said the world may be on the verge of an even more acute shortage. According to the American Physical Society, many of the 15,000 nuclear engineers now in the field in the United States are nearing retirement age and more than one-third are expected to retire in the next five years (online).

Berrigan (2007) of the industry trade association, the Nuclear Trade Institute, told a Congressional committee in 2007 that 19,600 current nuclear utility employees will be eligible to retire by 2012. The industry could lose more than 6,300 workers at the same time through attrition.

In July of 2008 Governor Brad Henry of Oklahoma signed the Aerospace Industry Engineer Work Force Bill. This bill provided tax credits for engineers and the Oklahoma companies that hired them. According to Stewart (2008), one in ten jobs in Oklahoma was related directly or indirectly to the aerospace industry. The bill addressed shortages in key occupations like airframe and power plant mechanics, aerospace engineers, electrical engineers and others, as the industry replaces employees “who have been working since human first walked on the moon in 1969” (Stewart, 2008).

Other areas of the country are also experiencing a need for engineers. Rovito (2007) reported there is a waning interest in engineering degrees across the United States, which has taken a toll on area industry in Milwaukee, Wisconsin. Rovito also stated that area firms have had to recruit internationally to find enough engineers.

Bernstein (2009) reported that institutions on Long Island were producing far fewer engineers than what local industry needed. According to Bernstein:

> A recent study by the Long Island Forum for Technology (LIFT) shows that four colleges and universities – Stony Brook University, Hofstra, New York Institute of Technology and Farmingdale State College – granted 317 undergraduate engineering degrees in 2008, less than 3 percent of the 11,585 diplomas issued last year.

> Using New York State Education Department data, the survey said "25 percent to 50 percent of the undergraduate and graduate students in the key demand category of engineering are foreign and have to return home after their degrees."
>
> Long Island companies told LIFT they will need 3,000 engineers over the next five years (online).

California is also facing a shortage of engineers. Engineer.net (2009) forecasted that California will need approximately 20,000 to 24,000 engineers to meet the need of the public and private sectors over the next decade. To meet this need, California's Governor Arnold Schwarzenegger proposed a plan in December 2008 to meet the need. Engineer.net (2009) outlined the Governor's plan, which included establishing programs at the University of California (UC) and California State University (CSU) to expedite certification for veterans with engineering backgrounds. This plan opens up important employment opportunities to the approximately 3,000 service members discharged to California each year who hold engineering-related military jobs. The plan also called for directing $1 million in federal Workforce Investment Act funds to develop new apprenticeship programs that partner private industry and California Community Colleges (CCC).

Additionally, the plan instructed the Engineering Education council to bring more private funds into "pipeline" programs at UC, CSU, CCC and other engineering programs. These programs help move math and science students into the engineering field. The Governor's plan wished to expand the statewide charter of High Tech High, a California charter school organization, to build out engineering-focused schools. In 2006, the State Board of Education approved 10 High Tech High charter schools; the Governor proposes to raise this number and expand its charter to grades K-12 (Engineering.net, 2009).

Several foreign nations are also experiencing a shortage of engineers. India needs to graduate an additional 65,000 engineers a year, on top of its annual 180,000 engineering graduates, to meet the needs of its Information Technology (IT) sector (Grose, 2006). Even though the country graduates an average of 350,000 engineering students each year, the software trade group Nasscom stated the IT sector alone will need 2.3 million engineers by 2010 (Grose, 2006). The Netherlands and Sweden are in need of young engineers. Van Lede, was quoted in 2001 saying: "This is not only a problem for these two countries or for Akzo Nobel, but for European governments and industry as a whole" (IIE, 2001). While engineering jobs are booming in Ireland, the popularity of an engineering career has been declining for over a decade (IIE, 2001a). The Institution of Engineers of Ireland (IEI) (as cited in IIE, 2001b) reported that there is a variety of career choices, plenty of work, and rising salaries, but fewer students are choosing to enter engineering careers.

The University of Manchester in the United Kingdom (UK) addressed the shortage of nuclear engineers by developing a new postgraduate course. IEE Review Careers (2004) reported: "A Department of Trade & Industry study in October 2002 identified a serious skills shortage in nuclear engineering with a projected 15,000 engineers required to fill the posts available" (online). A two-part report in *IEE Engineering Management* (Hodgson, Farr, & Gindy; 2004a, 2004b) addressed several issues the UK faced regarding the need for engineers. Hodgons, Farr, & Gindy reported technically advanced industries in the UK and other developed countries have relied on a regular intake of young graduate engineers as the basis for keeping up with technological advancements (2004a, p. 24); due to its current age profile, the UK population of engineers (and, in particular, chartered engineers) is likely to decline proportionately more rapidly than either the general population or the total active workforce (2004a, p. 25); the perceptions of most UK people (of all ages) are of boring, dirty jobs – perhaps not surprising when gas fitters, domestic washer service mechanics and other skilled and semi-skilled workers are often misleadingly called engineers (2004a, p. 27); the majority of UK engineers are nearing retirement and skilled engineers are disappearing from the workforce at an alarming rate (2004b); the UK will have a shortfall of engineers in excess of 100,000 by 2010 (2004b); and, in the UK, approximately two thirds of engineers remain in employment between the ages of 55 and 64; however, a substantial proportion of these have moved away from the engineering 'coalface' (2004b, p.32).

Characteristics of STEM Students

Popular culture has perpetuated a negative stereotype of engineers. Movies and television shows portray engineers as lacking social skills, being unpopular, poor dressers, and generally awkward. The National Science Board (2007) found:

> Engineers are commonly perceived as "nerds" without interpersonal skills, doing narrowly focused jobs that are prone to being outsourced. Most high school girls believe engineering is just for boys who love math and science. Students at historically black colleges and universities may see engineering as unfriendly,

> unaffordable, and requiring extra preparation. They do not see a direct benefit to their community and often believe they would have to leave their community to succeed in engineering. In part due to these perceptions, engineers remain underrepresented among women, African Americans, Hispanics, and Native Americans. Engineering also is seen as unattractive by many talented and creative people who could excel in engineering but are discouraged by the rigidity of the required studies and perceptions about uncertain career prospects. (pp. 2-3).

Sitaramiah (2006) reported that, while it may seem obvious, mastering math and science is a key to engineering. Potvin et al.'s, (2009) research found that engineering students had particularly high SAT math scores and comprehensive mathematics preparation (e.g. rates of completion of various calculus courses) compared to science students, although science students were more well-rounded in their pre-college academic preparation (e.g. high school English grades and SAT verbal scores). On average, engineering students had SAT Math scores that were 30 points higher than non-engineering students. Nicholls et al.'s (2007) examination of data from the Cooperative Institutional Research Program (CIRP) determined "quantitative indicators of strong STEM interest include high SAT mathematics scores, high grade point average, and to a lesser extent SAT verbal scores" (p. 42). Computer skills, academic ability, and self-rating of mathematical ability were other good qualitative measures of STEM ability (Nicholls et. al., 2007). Astin and Astin's (1992) research reported mathematical and academic preparation were strong indicators for student interest in engineering disciplines.

Tyson et al.’s, (2007) research investigated students’ high school math and science coursework in relation to race and gender, and their likeliness to pursue a STEM major in college. The researchers analyzed a subset of data from the Florida Longitudinal Education and Employment Dataset. The sample population included 94,078 students who graduated from Florida public high schools during the 1996-1997 school year. The longitudinal data describes items such as high school course-taking and post-baccalaureate achievements within Florida through the 2003-2004 school year. To aid in identifying and quantifying students’ highest mathematics and science courses, the authors adapted two sets of category codes. The eight mathematics categories were given a numerical code ranging from zero to seven, with zero equating to no mathematics and seven equating to Advanced III (Calculus, AP Calculus AB, AP Calculus BC). The nine science codes ranged from zero (none) to nine (Chemistry 2 or Physics 2).

Tyson et al.’s (2007) analysis of the data found that enrollment and attainment in physics and calculus was particularly important for all students with respect to obtaining a STEM degree. The researchers also concluded that “minority students who are prepared for STEM degree attainment by virtue of taking high-level science and mathematics courses, particularly calculus, chemistry, and physics at the highest levels, are more likely to persist through STEM coursework in college than their White counterparts and obtain a STEM degree” (p. 268). Similarly, “Hispanic students with advanced level course preparation are also more likely than White students to persist to obtain a STEM degree” (Tyson, et al., 2007, p.268).

York’s (2008) analysis of 92 published high school valedictorians profiles in the Research Triangle of central North Carolina from 2003 to 2005 yielded data the showed there were “statistically significant gender interest differences in the mathematics, computer science, or engineering majors and in the humanities or social science majors” (p. 590). The analysis also concluded that a significantly greater proportion of males than females planned to enter STEM majors. The National Science Board (2000) found that, while women make up nearly half the employees in the United States workforce, they are underrepresented in STEM fields, holding only 9% of engineering, 22% of physical science, and about 20% of all combined STEM positions.

Summers and Hrabowksi (2006) found “the same percentage (44%) of African American and Caucasian college-bound high school students indicated their intent to major in science and engineering (S&E) fields” (p. 1870). Peng’s et al. (1995) report concluded the following: all ethnic-race groups had equally positive attitudes toward science, and similar aspirations for science and mathematics- related careers; as many minority students grew older their interest waned as they fell behind in mathematics and science courses; and a large percentage of minority students in the report attended schools that did not have a rigorous curriculum that prepared them for science and mathematics-related fields. Ohland’s et al., (2008) analysis of the 2007 Multiple-Institution Database for Investigating Engineering Development (MIDFIELD) and the 2007 National Survey of Student Engagement (NSSE) concluded “engineering students showed little difference in demographics compared to those in other majors, with the notable exception that there is a dearth of women enrolled in these programs relative to their general presence in higher education" (p. 261). The researchers' analysis of the NSSE data also showed no "important differences" in proportions of enrollment between engineering students and student of other majors in terms of first-generation status and race.

Goyette and Mullen's (2006) research of who studies the arts and sciences found that students who study math and science majors had lower socio-economic status (SES) than did humanities or social science majors. They report that "even slightly lower SES than engineering majors – while engineering majors had the highest SES among the vocational majors" (p. 509). Potvin's et al., (2009) research determined, when measured by parent's education level, engineering students had lower SES than science students.

Ohland's et al., (2008) study of students' persistence, engagement, and migration in engineering programs revealed the following observations of students' self-reported characteristics: engineering students spend more time each week preparing for class; engineering and other science, technology, and math (STM) students participate slightly more frequently than students in other majors in co-curricular activities; about 60 percent of students in engineering and other STM, and social sciences completed a practicum- or internship- type experience, compared to approximately 45 percent for other majors" (p. 271); and 11 percent of engineering students participated in study abroad programs.

Existing Programs Designed to Increase Interest in Engineering and Science

There are numerous initiatives in place for developing middle and high school students' interest in engineering. These programs are designed to encourage them to purse engineering in college. Project Lead The Way (PLTW) is a national 501(c)(3), not-for-profit educational program that helps give middle and high school students the rigorous ground-level education they need to develop strong backgrounds in science and engineering (Project Lead The Way, 2007-2008). The Junior Engineering Technical Society (JETS) makes engineering "real," "relevant," and "fun" by helping students discover engineering for themselves. They provide programs and resources that let students learn about and experience engineering first-hand. From student competitions to assessment tools and career exploration materials, JETS helps students plan for rewarding futures by showing them how engineering can help them pursue their dreams (Junior Engineering Technical Society, 2009).

The Foundation for the Inspiration and Recognition of Science and Technology (FIRST) was founded in 1989 to inspire young people's interest and participation in science and technology. Based in Manchester, NH, the 501(c)(3) not-for-profit public charity designs accessible, innovative programs that motivate young people to pursue education and career opportunities in science, technology, engineering, and math, while building self-confidence, knowledge, and life skills (US FIRST, n.d.).

The ASEE EngineeringK12 Center seeks to identify and gather in one place the most effective engineering education resources available to the K-12 community. It works to enhance achievement in pre-college science, technology, engineering, and mathematics (STEM) education by promoting the effective application of engineering principles to K-12 curricula (American Society for Engineering Education, 2007).

Women in Engineering ProActive Network (WEPAN) is a national not-for-profit organization with over 600 members from engineering schools, small businesses, Fortune

500 corporations, and non-profit organizations. WEPAN seeks to transform culture in engineering education to attract, retain, and graduate women. With a focus on research-based issues and solutions, WEPAN helps its members develop a highly prepared, diverse engineering workforce for tomorrow (Women In Engineering ProActive Network, 2005).

The National Action Council for Minorities in Engineering (NACME) is the nation's largest private provider of scholarships for underrepresented minority students in engineering. They have forged collaborations with other non-profit organizations to provide pre-engineering study preparation and experiences for public school and community college students. They have become a leading source of research results and policy analysis regarding the participation of African Americans, Latinos and American Indians in engineering education and careers (National Action Council for Minorities in Engineering, 2009).

TryEngineering.org, a program sponsored by IBM, IEEE, and TryScience, is a resource for students (ages 8-18), parents, teachers and, school counselors. This website focuses on engineering and engineering careers, and how an engineering career can be explored. Students find descriptions of the lifestyles and experiences of engineers and on the different disciplines within engineering. Useful tips on course selection, applying to university programs and financial aid are also included (TryEngineering, n.d.).

In addition to these programs and services, there are camp opportunities for pre-college students who are interested in the field of engineering. North Carolina State University (2009) offers numerous camps for elementary, middle, and high school students who wish to learn more about engineering. California Polytechnic State University's (2009) Engineering Possibilities in College (EPIC) is a one-week summer program for high school students (9th-12th) to learn about engineering and experience hands-on labs in a university atmosphere. The Purdue School of Engineering and Technology's (2009) Preparing Outstanding Women for Engineering Roles (POWER) summer camp for high school females gives students the opportunity to explore engineering through hands-on, learn-by-doing experiences. The Massachusetts Institute of Technology's (2009) Minority Introduction to Engineering and Science (MITES) is a rigorous six-week residential, academic enrichment summer program for promising high school juniors who are interested in studying and exploring careers in science and engineering. Clemson University (2009) offers a summer enrichment program for gifted middle and high school students. In addition to challenging courses, the university provides opportunities for fun, friendship and a university experience.

Chapter Summary

This chapter examined the literature concerning the need for more engineers, characteristics of STEM students, and existing programs designed to increase interest in engineering and science. Research has shown that engineers will retire at a dramatic rate over the next 20 years (Brown, 2005) and that fields such as the oil industry (Anderson, 2008), VoIP (Harris, 2008), and nuclear energy (Thomas, 2008) were suffering with shortages of engineers. Studies conducted by National Science Board (2007) found that popular media have portrayed negative stereotypes of engineers, while other research (Ohland, 2008) found that engineering students were well-rounded. Chapter two concluded with an overview of international, national, and university-based programs designed to increase interest in engineering.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

Introduction

The purpose of this research study was to identify variables that significantly influence a high school student to pursue an undergraduate engineering degree. The overarching research question for the study was: What characteristics of high school students influence them to enroll in engineering their first year in college? The following specific research questions guided the study:

1. What are the demographic characteristics of students entering a freshmen engineering or physical science program?
2. What variables have a significant influence on a student's decision to pursue an engineering degree versus physical science degree in college?

Research Design

The study utilized a non-experimental cross-sectional survey of first-time college freshmen enrolled in general engineering or a physical science major. The survey was developed by Porter (2010), and entitled the "High School Activities, Characteristics, and Influences Survey." Creswell (2003) stated "Surveys include cross-sectional and longitudinal studies using questionnaires or structured interviews for data collection, with the intent of generalizing from a sample to a population" (p. 14).

The researcher utilized a web-based survey for the research project. The web-based survey followed guidelines set-forth by Dillman (2007). These guidelines were: (a) attention to participant-researcher trust; (b) follow-up communication; (c) expression of appreciation for participation; (d) unambiguous layout; (e) clear and concise questions; (f) easy navigation; (g) shaded categories; and (h) consistent response tool for all questions (Dillman, 2007).

Unit of Analysis

The study was a non-experimental survey of first-time general engineering and physical science (Chemistry, Computer Information Systems, Computer Science, Geological Sciences, Mathematical Sciences, Physics, and Polymer and Fiber Chemistry) students enrolled in a large, four-year, research university in the southeastern United States. The unit of analysis for the study is each individual student surveyed. The survey instrument collected quantitative and qualitative data from the population, and this approach allows for capturing unique data about each individual student.

The concept of the study began with the researcher's desire to understand why high school students wish to pursue an undergraduate engineering degree, and what characteristics these students have in common. There were many research articles on what STEM students do when they are already in college, but relatively little research was uncovered about what future STEM students do while they are in high school. Data collected from the survey instrument was analyzed to uncover what, if any, characteristics influence students to enroll in an undergraduate engineering major.

Participants

The participants for the study were first-time college freshmen enrolled in general engineering or a physical science major. The survey instrument was administered to approximately 911 general engineering students and 165 physical majors (Chemistry B.A., Chemistry B.S., Computer Information Systems B.S., Computer Science B.A., Computer Science B.S., Geological Sciences B.A., Geological Sciences B.S., Mathematical Sciences B.A., Mathematical Sciences B.S., Physics B.A., Physics B.S., and Polymer and Fiber Chemistry B.S.). The students were enrolled at a large, four-year, research university in the southeastern United States. All students who planned to enroll in an engineering discipline must enroll in general engineering for their freshman year, while science freshmen begin college in their respective discipline. The researcher met the students in class to discuss the survey, or had the department e-mail the survey to the students. Students were given a web address where the online survey could be accessed. While the survey results were not attached to specific respondents, students who wished to be considered for a prize draw were able to indicate their student e-mail addresses at the end of the survey.

Instrumentation

The survey instrument for this study was a survey developed by the researcher. Before being administered to the sample population, a pilot survey was administered to 90 students to assess aspects of validity and reliability, and the time needed to complete the survey. After analyzing results from the pilot group, the researcher deleted and edited several questions. Survey results from a second group of thirty students was used to confirm changes made from the first pilot group. Creswell (2003) defined validity as "whether one can draw meaningful and useful inferences from scores on the instruments" (p. 157) and reliability as internal and external consistency within the instrument.

Variables Used for Study

The independent (predictor) and dependent (criterion) variables were based upon the two research questions. Creswell (2003) defined independent variables as "variables that (probably) cause, influence, or affect outcomes; they are also called treatment, manipulated, antecedent, or predictor variables" (p. 94). Dependent variables are those which depend on the independent variables. Dependent variables are the influence, or outcome, of the independent variables; additional names for dependent variables include criterion, outcome, and effect variables (Creswell, 2003).

The independent variables for this survey are based upon Lent's Social Cognitive Career Theory. These variables include: (a) self-efficacy (Table 3.1), (b) outcome expectations (Table 3.2), (c) interests (Table 3.3), (d) social supports and social barriers (Table 3.4). The dependent variable was the students' decision to enroll in an undergraduate engineering or physical science major (major choice goal). See also Appendix B for full statement of the survey items.

Table 3.1

Questions Measuring Self-Efficacy

Indicate your level of confidence in your ability to SOLVE PROBLEMS
Indicate your level of confidence in your ability to SOLVE PROBLEMS WHILE WORKING ALONE
Indicate your level of confidence in your ability to SOLVE COMPLEX MATH PROBLEMS
Indicate your level of confidence in your ability to BE CREATIVE
Indicate your level of confidence in your ability to WORK ON A TEAM
Indicate your level of confidence in your ability to COMMUNICATE EFFECTIVELY
Indicate your level of confidence in your ability to HAVE ATTENTION TO DETAIL

Table 3.2

Questions Measuring Outcome Expectations

What is your current major at XXXX University?
If you have a second major (double-majoring), please indicate it.
What degree do you plan to graduate with?
If you indicated "other," please list the degree you plan to graduate with.
How important were the following criteria in your decision to pursue your current major?
Working in an area with lots of job opportunities/ working with people, rather than objects/ Having an exciting job
In what grade did you decide you wanted to pursue your current major?

Table 3.3

Questions Measuring Interests

Did you attend science/ math/ engineering camps while in high school?

Please indicate which Project Lead The Way (PLTW) classes you were enrolled in while in high school.

What subject had the largest influence on you pursuing your current major?

Did you enroll in classes through a college or university while in high school; if so, check all that apply.

How important were the following criteria in your decision to pursue your current major?

Helping other people/ Making money/ Job security

How important were the following criteria in your decision to pursue your current major? Inventing new things/ making your own decisions/ Making use of your talents and abilities

How many times did you visit science/ math/ engineering museums while still in high school?

What was your favorite subject(s) in high school? Please check all that apply.

Did you participate in high school science fairs?

Did you regularly watch science/ engineering television shows prior to enrolling in college? For example: Mythbusters, Megamachines, NOVA, How It's Made?...

Did you regularly read science/ engineering magazines prior to enrolling in college? For example: Popular Mechanics, Popular Science, National Geographic, Science, Discover…

Table 3.3 (cont.)

Questions Measuring Interests

Please indicate each of the programs you participated in prior to enrolling in college. MathCounts/ Gateway to Technology/ Project Lead The Way (PLTW)/ Junior Engineering Technical Society (JETS)/ Foundation for the Inspiration and Recognition of Science and Technology (FIRST)/ Southeastern Consortium for Minorities in Engineering (SECME)/ None of the above

Table 3.4

Questions Measuring Social Supports and Social Barriers

What is your current age?
What year did you graduate high school?
Please indicate all of the math courses you completed for high school credit.
Please indicate all of the science courses you completed for credit.
What other Advanced Placement (AP) classes did you complete in high school?
Did you take the AP BIOLOGY Exam?
Did you take the AP CALCULUS AB Exam?
Did you take the AP CALCULUS BC Exam?
Did you take the AP CHEMISTRY Exam?
Did you take the AP PHYSICS B Exam?
Did you take the AP PHYSICS C (ELECTRICTY AND MAGNETISM) Exam?
Did you take the AP PHYSICS C (MEACHINCS) Exam?

Table 3.4 (cont.)

Questions Measuring Social Supports and Social Barriers

Did you participate in an International Baccalaureate (IB) program at your high school?

Please indicate your highest score on the SAT MATH SUBTEST.

Please indicate your highest score on the SAT CRITICAL READING SUBTEST.

Please indicate your highest score on the SAT WRITING SUBTEST.

Please indicate your highest ACT COMPOSITE SCORE.

Please indicate your highest score on the ACT ENGLISGH SUBTEST.

Please indicate your highest score on the ACT MATH SUBTEST.

Please indicate your highest score on the ACT READING SUBTEST.

Please indicate your highest score on the ACT SCIENCE SUBTEST.

Please indicate your highest score on the ACT WRITING SUBTEST.

Please indicate all of your family members who are employed in an engineering/ science profession.

Rate the level of influence the following person(s) had on your decision to pursue your current major. Mother / Female Guardian/ Father / Male Guardian/ Sibling(s)/ Other Relative(s)/ Peers/ High School Math Teacher(s)/ High School Chemistry Teacher/ High School Other Teachers/ High School Guidance Counselor

While in high school, did you job shadow a person who works as an engineer, scientist, or mathematician?

Rate the level of support your home environment had towards your current major.

Please enter the 5-digit zip code for the high school you attended prior to enrolling in XXXX University.

What is your gender?

What is your race?

Table 3.4 (cont).

Questions Measuring Social Supports and Social Barriers

Are you of Hispanic origin?
Was English the primary language spoken in your household?
What was the highest level of education for your parent/ guardian? Male parent/ guardian / Female parent/ guardian

Data Collection

The study utilized a web-based data collection device. The web-based survey allowed respondents to complete the survey and not interfere with classroom instruction, allowed for "smart" guided questions, provided legible responses, and allowed for anonymity. Self-reported data collected from the survey was used to measure the independent and dependent variables. Research conducted by Kuncel, Crede, and Thomas (2005) found:

- "There were no large differences in the validity of self-reported GPA of males and females. The validity of self-reported GPA for White students was higher than the validity of self-reported GPA for non-white students" (p. 72).
- "The validities of self-reported scores on standardized SAT-Verbal and SAT-Mathematics were comparable to the validities of self-reported high school GPA" (p. 72).

- “The results clearly indicate that the lower levels of school performance are associated with considerable lower levels of reliability for self-reported grades. Again, a moderating effort is observed, such that students with lower levels of cognitive ability (as measured by standardized admissions tests) tend to report their GPAs less reliably” (p. 74).
- “The incidences of under-reported grades, accurately reported grades, and over-reported grades were similar for men and women, and for Whites and non-White students. Only 36.1% of SAT-total scores were reported accurately, with a far larger proportion of scores being over-reported (54.8%) than under-reported (12.1%)” (p. 74).

Prior to meeting the students in their major-specific classes, the researcher gained approval from department chairs to have access to the students. The 64-item online survey was available for one week after the class meetings. Three days after the class meeting the researcher sent an e-mail to the participants reminding them to complete the survey. All survey results were saved on a password-protected server for analysis.

Data Analysis

The study utilized Microsoft Excel and R for data analysis. The researcher computed descriptive statistics for response variables and tallied frequencies and percentages for demographic variables. Two sample t-tests, Two-sample Wilcoxon tests and binomial logistical regression were further used to analyze the data.

Role of the Researcher and Bias

As the Director of Undergraduate Recruitment for the College of Engineering and Science at a research university, I am charged with recruiting the best and brightest minds from across the United States. My position involves working with prospective high school students, their parents, high school teachers and guidance counselors, and industry.

Each year I spend tens of thousands of dollars on publications, mailings, phone calls, travel, and event sponsorships to help recruit top students. Therefore, it is in my best interest to better understand what makes high school students “tick” and find more effective uses of my limited resources to recruit future engineers and scientists.

Chapter Summary

The purpose of this chapter was to outline and discuss the methodology for the investigation into the characteristics and activities which influence high school students to enroll in an undergraduate engineering program. The chapter reintroduced the research questions, discussed the research design, and introduced the unit of analysis. Variables used for the study, the study participants, instrumentation, data collection, data analysis, and the role of researcher and bias were also discussed.

CHAPTER 4

PRESENTATION OF FINDINGS

Introduction

The purpose of this research study was to identify variables that significantly influence a high school student to pursue an undergraduate engineering degree. The overreaching research question for the study was: What characteristics of high school students influence them to enroll in engineering their first year in college? The study controlled for student's major and year of enrollment. Data was collected from the High School Activities, Characteristics, and Influences Survey that was administered at the beginning of the Fall 2010 term. Collected data were analyzed using descriptive statistics, two-sample Wilcoxon tests, and binomial logistic regression techniques. The study was guided by the following research questions:

1. What are the demographic characteristics of students entering a freshmen engineering or physical science program?
2. What variables have a significant influence on a student's decision to pursue an engineering degree versus physical science degree in college?

Description of the Data

The study population consisted of all first-year engineering and physical science students enrolled at a large, four-year, research university in the southeastern United States. The High School Activities, Characteristics, and Influences Survey was administered to 1,075 students freshmen enrolled in general engineering or physical science majors. Four hundred thirteen general engineering and physical science students responded to the survey, yielding a response rate of 38%. A small number of responding students (<10), who were non-engineering or non-physical science majors, were not included in the data analysis.

Analysis of Research Questions

Research question one asked what are the demographic characteristics of students entering a freshmen engineering program? For the purpose of this study, the following items were analyzed to determine the demographic characteristics of the students: Gender, Race, English as primary language, SAT scores, ACT scores, Residency, Parent's highest level of education, AP scores in Calculus, Chemistry, and Physics, and Household income.

RESEARCH QUESTION ONE

Gender

The majority of the students were male. Out of 413 respondents, 66% (n = 273) identified themselves as male and 34% (n = 140) identified themselves as female. Table 4.1 illustrates the gender breakdown by discipline.

Table 4.1

Gender by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
Female	115 (34%)	25 (35%)
Male	226 (66%)	47 (65%)

Results shown in Table 4.1 illustrate that a larger proportion of male students enroll in STEM disciplines than female students. SCCT might suggest that female students are not receiving social support from family members or peers to enroll in STEM disciplines or are experiencing social barriers from peers, who are discouraging them from pursuing a technical major. Female students may also lack interest in STEM disciplines due to poorer instruction during their middle and high school years. The combination of social barriers and lack of interest may also affect female students' self-efficacy and their perceived ability to be successful in STEM disciplines.

Race

Participants were given the option of selecting one of six race classifications. The classifications included: (a) Native American/Alaskan Native, (b) Caucasian/White, (c) Pacific Islander (Guamanian, Chamorro, Samoan), (d) African American/Black, (e) Asian (Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, or other Asian), (f) and Mixed. Table 4.2 illustrates the race breakdown by discipline.

Table 4.2

Race by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
Native American/Alaskan Native	0 (0%)	0 (0%)
Caucasian/White	294 (86%)	61 (85%)
Pacific Islander	1 (<1%)	0 (0%)
African American/Black	21 (6%)	2 (3%)
Asian	15 (4%)	5 (7%)
Mixed*	9 (3%)	4 (5%)

*"Mixed" includes participants who identified themselves as biracial or multiracial (Smith, 2004).

Table 4.2 illustrates that the race distribution for engineering and physical science students were similar. The race breakdown of the sample population is similar to the race breakdown of the freshmen class of the university where the survey was conducted. The first-time Freshmen population of engineering and physical science students at the study university was 83% Caucasian/White, 7% African American/Black, 3 % Asian, 2 % Mixed, and both Native American/Alaskan Native and Pacific Islander composed less than 1% of the population. SCCT might suggest that Caucasian/White students benefit from the social supports, interests, and self-efficacy building experiences that lead them to pursue STEM disciplines, while students of other racial backgrounds do not benefit from these factors to the same extent. Additionally, non-Caucasian/White students might have also experienced social barriers that prevented them from enrolling in STEM disciplines.

English as primary language

Students were asked if English was the primary language spoken in their household. Of 411 respondents, 93% (*n* = 385) indicated that English was the primary language spoken in their household. Table 4.3 illustrates English primarily spoken in a student's household by discipline.

Table 4.3

English as Primary Language by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
English Primary Language	319 (94%)	66 (93%)
English NOT Primary Language	21 (6%)	5 (7%)

SAT scores

Students were asked to indicate their highest score on the SAT sections of Critical Reading, Mathematics, and Writing Sample. The mean Mathematics score for all responding, n = 373, was 669. The mean Critical Reading score for all responding, n = 367, was 617. The published sample university composite mean Critical Reading and Mathematics score for all Freshmen engineering and physical science students were 1266 and 1286. Table 4.4 illustrates SAT Critical Reading and Mathematics scores by discipline.

Table 4.4

SAT Subject Scores by Discipline as Reported by Participants

	Engineering (N)	Physical Science (N)
Critical Reading	614 (307)	634 (60)
Mathematics	669 (312)	668 (61)
Total Score	1283	1302

SCCT might suggest both engineering and physical science students have strong social supports from parents and teachers which prepare and encourage them to do well on the Scholastic Aptitude Test. The engineering and physical science students may also have high self-efficacy regarding their mathematics abilities, which led them to do well on the examination. The high level of interest the sample population had in mathematics may have also led to them doing well on the examination.

ACT scores

Students were asked to indicate their highest score on the ACT sections of English, Math, Reading, Science, Writing, as well as their Composite Score. The mean English score for all responding, n = 203, was 28. The mean Math score for all responding, n = 208, was 30. The mean Reading score for all responding, n = 201, was 28. The mean Science score for all responding, n = 200, was 28. The mean Writing score for all responding, n = 180, was 25. The mean Composite score for all responding, n = 246, was 28. The published university mean composite ACT scores for all Freshmen engineering and physical science students were 29 and 29 respectively. Table 4.5

illustrates the ACT Composite, English, Math, Reading, Science, and Writing scores by discipline.

Table 4.5

ACT Subject Scores by Discipline as Reported by Participants

	Engineering (N)	Physical Science (N)
Composite	28 (201)	29 (45)
English	26 (170)	28 (33)
Math	30 (174)	29 (34)
Reading	28 (169)	29 (32)
Science	28 (169)	29 (31)
Writing	25 (152)	27 (28)

As with the SAT, SCCT might suggest both engineering and physical science students have strong social supports from parents and teachers which prepare and encourage them to do well on the ACT. The engineering and physical science students may also have high self-efficacy regarding their mathematics abilities, which led them to do well on the examination. The high level of interest the sample population had in mathematics may have also led to them doing well on the examination.

Residency

Students were asked to indicate their residence by selecting the state from which they graduated from high school, or if they were an international student. 215 engineering students (63%) indicated they were in-state, while 122 (36%) indicated they were out-of-state, and four (1%) indicated they were international students. Fifty four physical science students (75%) indicated they were in-state, while 17 (24%) indicated they were out-of-state, and 1 (1%) indicated they were an international student. Table 4.6 illustrates the respondents' residency by major.

Table 4.6

Participants' Residency by Major

	Engineering N (%)	Physical Science N (%)
In-State	215 (63%)	54 (75%)
Out-of-State	122 (36%)	17 (24%)
International	4 (1%)	1 (1%)
Total	341	72

In-state students were the majority of both engineering and physical science students. Particular social supports, such as lower in-state tuition, financial incentives, and parental and peer influences would lead an in-state student to attend an in-state student. Out-of-state and international students may experience social barriers including higher out-of-state tuition, separation from parents and friends, and lack of familiarity with the new state and institution. International students may experience the additional social barriers of unfamiliar culture, customs, and foreign language. SCCT might also suggest that in-state students attended the sampled institution because they have higher outcome expectations that the study university will better prepare them for their future endeavors.

Parent's highest level of education

Students were asked to indicate the highest level of education for their female parent/guardian and male parent/guardian. Of the engineering respondents, 242 (71%) indicated their female parent/guardian had at least a Bachelor's degree, while 44 of the physical science respondents (61%) indicated their female parent/guardian had a least a Bachelor's degree. Of the engineering respondents, 245 (72%) indicated their male parent/guardian had a least a Bachelor's degree, while 44 of the physical science respondents (61%) indicated their male parent/guardian had at least a Bachelor's degree. Table 4.7 illustrates the female parent/guardian's highest level of education and Table 4.8 illustrates the male parent/guardian's highest level of education.

Table 4.7

Female Parent/ Guardian's Highest Level of Education by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
Less than a High School Diploma	6 (2%)	2 (3%)
High School Diploma/ GED	27 (8%)	11 (15%)
Some College/ Associate's Degree	66 (19%)	15 (21%)
Bachelor's Degree	178 (52%)	27 (38%)
Master's Degree or Ph.D.	54 (16%)	14 (19%)
Professional Degree	7 (2%)	3 (4%)
Not Applicable	3 (1%)	0 (0%)
Total	341	72

Table 4.8

Male Parent/ Guardian's Highest Level of Education by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
Less than a High School Diploma	0 (0%)	5 (7%)
High School Diploma/ GED	43 (13%)	9 (13%)
Some College/ Associate's Degree	47 (14%)	14 (19%)
Bachelor's Degree	146 (43%)	21 (29%)
Master's Degree or Ph.D.	76 (22%)	16 (22%)
Professional Degree	23 (7%)	7 (10%)
Not Applicable	5 (1%)	0 (0%)
Total	340	72

SCCT might suggest that the majority of the respondents had strong social support from their parents, based upon the fact that a majority of the respondents indicated their parents had at least a Bachelor's degree. By having earned at least a Bachelor's degree, these parents may understand the value of a college education, understand the importance of taking the proper classes in high school to prepare one's self for college, and have a better understanding of the resources available to students in college. At the same time, parents may have encouraged their children to pursue a degree that will help reap better rewards in the future. Respondents with parents who had obtained post-Baccalaureate degrees might have experienced additional supports, as these parents sought further educational pursuits.

AP exam scores in Calculus, Chemistry, and Physics

Students were asked to indicate if they took the AP exams in the subjects of Calculus, Chemistry, and Physics. If the student took the exam they were asked to indicate their highest score (1 to 5). Table 4.9 illustrates the students' scores on the AP Calculus AB exam. Table 4.10 illustrates the students' scores on the AP Calculus BC exam. Table 4.11 illustrates the students' scores on the AP Chemistry exam. Table 4.12 illustrates the students' scores on the AP Physics B exam. Table 4.13 illustrates the students' scores on the AP Physics C (Electricity and Magnetism) exam. Table 4.14 illustrates the students' scores on the AP Physics C (Mechanics) exam.

Table 4.9

AP Calculus AB Exam Score by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
AP Calculus AB was not offered at my school	27 (8%)	6 (8%)
AP Calculus AB was offered at my school, but I did not participate	85 (26%)	24 (34%)
I took the AP Calculus AB class, but not the exam	11 (3%)	3 (4%)
One	24 (7%)	4 (6%)
Two	24 (7%)	4 (6%)
Three	27 (8%)	5 (7%)
Four	43 (13%)	13 (18%)
Five	92 (28%)	12 (17%)

A majority of the respondents had the opportunity to enroll in AP Calculus AB, however, many decided not to enroll in the course. While a small number of students who took the class did not take the AP exam, most of those who did take the exam scored a four or five. SCCT might suggest the respondents that the students who made a three or four, had high self-efficacy and interest in mathematics which led to the higher test scores. These same students may have has received social supports from parents, teachers, and counselors who encouraged them to enroll in the AP class.

At the same time, 27% of all respondents attended a school where AP Calculus AB was offered, but they decided not to enroll in the class. These students may have attended a school with a poor AP Calculus AB program, received poor advising from teachers or guidance counselors, or they determined they were not able to do AP Calculus AB-level work. SCCT might suggest that these students were affected by social barriers, low self-efficacy, or simply had no interest in AP Calculus AB.

Table 4.10

AP Calculus BC Exam Score by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
AP Calculus BC was not offered at my school	117 (38%)	26 (36%)
AP Calculus BC was offered at my school, but I did not participate	131 (43%)	32 (44%)
I took the AP Calculus BC class, but not the exam	6 (2%)	0 (0%)
One	4 (1%)	1 (1%)
Two	3 (1%)	0 (0%)
Three	16 (5%)	1 (1%)
Four	20 (7%)	4 (6%)
Five	9 (3%)	8 (11%)

Unlike AP Calculus AB, AP Calculus BC was not offered in over a third, 38%, of the respondents' schools. Because of this, SCCT might suggest this lack of AP Calculus

BC as a social barrier which prevents these students from enrolling in a higher level mathematics course. Reasons for the school not offering AP Calculus BC could include lack of student interest, no qualified teachers to teach the class, or a lack of funding – all of which could be considered social barriers.

Almost one-half, 43%, of the respondents indicated AP Calculus BC was offered at their school, but they did not participate. SCCT might suggest these students had a lack of interest in enrolling in AP Calculus BC. These students may have also lacked the support from teachers and parents which prevented them from enrolling in the course. Finally, respondents may have felt hesitant and underprepared for AP Calculus BC, leading to low self-efficacy, which led them to not enroll in AP Calculus BC.

Table 4.11

AP Chemistry Exam Score by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
AP Chemistry was not offered at my school	84 (25%)	24 (33%)
AP Chemistry was offered at my school, but I did not participate	160 (48%)	27 (38%)
I took the AP Chemistry class, but not the exam	9 (3%)	1 (1%)
One	8 (2%)	4 (6%)
Two	8 (2%)	0 (0%)
Three	14 (4%)	3 (4%)
Four	32 (10%)	3 (4%)
Five	19 (6%)	10 (14%)

AP Chemistry was not offered in over a quarter, 27%, of the respondents' schools. Because of this, SCCT might suggest this lack of AP Chemistry as a social barrier which prevents these students from enrolling in a higher level science course. Reasons for the school not offering AP Chemistry could include lack of student interest, no qualified teachers to teach the class, or a lack of funding – all of which could be considered social barriers.

Almost one-half, 47%, of the respondents indicated AP Chemistry was offered at their school, but they did not participate. SCCT might suggest these students had a lack of interest in enrolling in AP Chemistry. These students may have also lacked the support from teachers and parents which prevented them from enrolling in the course. Students may have had low outcome expectations for AP Chemistry which kept them from participating in the class. Finally, respondents may have felt hesitant and underprepared for AP Chemistry, leading to low self-efficacy, which led them to not enroll in AP Chemistry.

Table 4.12

AP Physics B Exam Score by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
AP Physics B was not offered at my school	171 (52%)	38 (51%)
AP Physics B was offered at my school, but I did not participate	108 (33%)	28 (38%)
I took the AP Physics B class, but not the exam	5 (2%)	1 (1%)
One	2 (1%)	0 (0%)
Two	3 (1%)	0 (0%)
Three	13 (4%)	1 (1%)
Four	17 (5%)	3 (4%)
Five	13 (4%)	3 (4%)

Half, 51%, of the respondents indicated that AP Physics B was not offered at their school. SCCT would suggest AP Physics B not being offered to these students as a social barrier. Reasons for the school not offering AP Physics B could include lack of student interest, no qualified teachers to teach the class, or a lack of funding – all of which could be considered social barriers.

A third of respondents indicated that AP Physics B was offered at their school, but they did not participate. According to the College Board (2011), the content of AP Physics B "is not the usual preparation for more advanced physics and engineering courses;" therefore, students in this survey would be less inclined to enroll in this course. SCCT would suggest that respondents would lack the interest and have low outcome expectations for AP Physics B, which led them not to enroll in the course.

Table 4.13

AP Physics C (Electricity and Magnetism) Exam Score by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
AP Physics C (Electricity and Magnetism) was not offered at my school	240 (73%)	47 (65%)
AP Physics C (Electricity and Magnetism) was offered at my school, but I did not participate	74 (22%)	19 (26%)
I took the AP Physics C (Electricity and Magnetism) class, but not the exam	5 (2%)	0 (0%)
One	1 (0%)	0 (0%)
Two	2 (1%)	1 (1%)
Three	1 (0%)	1 (1%)
Four	5 (2%)	2 (3%)
Five	2 (1%)	2 (3%)

Almost three-quarters (72%) of the respondents indicated that AP Physics C (Electricity and Magnetism) was not offered at their school. SCCT would suggest AP Physics C (Electricity and Magnetism) not being offered to these students as a social barrier. Reasons for the school not offering AP Physics C (Electricity and Magnetism) could include lack of student interest, no qualified teachers to teach the class, or a lack of funding – all of which could be considered social barriers.

Slightly less than one-quarter, 23%, of the students indicated that AP Physics C (Electricity and Magnetism) was offered at their school, but they did not participate. According to the College Board (2011), AP Physics C (Electricity and Magnetism) forms "part of the college sequence that serves as the foundation in physics for students majoring in the physical sciences or engineering." It is somewhat contradictory that students pursuing an engineering or physical science degree would decide to not enroll in a course that would prepare them for their intended major. SCCT might suggest these students experienced a social barrier such as a course scheduling conflict or peer pressure from fellow students to not enroll in high level science course.

Table 4.14

AP Physics C (Mechanics) Exam Score by Discipline as Reported by Participants

	Engineering N (%)	Physical Science N (%)
AP Physics C (Mechanics) was not offered at my school	215 (65%)	44 (61%)
AP Physics C (Mechanics) was offered at my school, but I did not participate	67 (20%)	20 (28%)
I took the AP Physics C (Mechanics) class, but not the exam	7 (2%)	0 (0%)
One	3 (1%)	1 (1%)
Two	4 (1%)	1 (1%)
Three	12 (4%)	0 (0%)
Four	13 (4%)	2 (3%)
Five	11 (3%)	4 (6%)

Nearly two-thirds, 64%, of the respondents indicated that AP Physics C (Mechanics) was not offered at their school. SCCT would suggest AP Physics C (Mechanics) not being offered to these students as a social barrier. Reasons for the school not offering AP Physics C (Mechanics) could include lack of student interest, no qualified teachers to teach the class, or a lack of funding – all of which could be considered social barriers.

Slightly less than one-quarter, 22%, of the students indicated that AP Physics C (Mechanics) was offered at their school, but they did not participate. According to the

College Board (2011), AP Physics C (Mechanics) forms “part of the college sequence that serves as the foundation in physics for students majoring in the physical sciences or engineering.” As with AP Physics C (Electricity and Magnetism), it is somewhat contradictory that students pursuing an engineering or physical science degree would decide to not enroll in a course that would prepare them for their intended major. SCCT might suggest these students experienced a social barrier such as a course scheduling conflict or peer pressure from fellow students to not enroll in high level science course.

Household income

Utilizing the respondents’ high school zip code and median household income from the 2000 U.S. Census (U.S. Census Bureau, 2000) the mean household income, in 1999 dollars, for all respondents was $49,915 (*SD* = $17,605). The mean household income for engineering students was $49,900 (*SD* = $17,538), while the mean household income for physical science students was $49,987 (*SD* = $18, 067). The mean household for all Americans was $41,994. SCCT might suggest, that by having a higher household income, respondents have more social supports, including better schools, access to more academic resources, and other opportunities.

RESEARCH QUESTION TWO

Research question two asked what variables have a significant influence on a student’s decision to pursue an engineering or physical science degree in college? First, in order to determine which variables had a significant difference between engineering and physical sciences students, a two-sample Wilcoxon test was run on the 277 measured variables (see Tables 3.1 – 3.4) collected in the survey. The Wilcoxon test was selected because, unlike a t-test, it does not assume normality in the distribution (Boersma, 2010). A total of 29 tests estimated a p-value of less than .05 and were deemed significant. The significant variables are identified in Tables 4.15 – 4.18.

Table 4.15

Significant Variables by SCCT Category – Self-efficacy

Variable	Significance	Mean	
		GE	PS
Solving problems alone	*	5.42	5.66
Working on a team	*	5.84	5.50

Significant codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05

Table 4.16

Significant Variables by SCCT Category - Outcome Expectations

Variable	Significance	Mean	
		GE	PS
Grade decided to pursue major	*	10.23	10.91

Significant codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05

Table 4.17

Significant Variables by SCCT Category – Interests

Variable	Significance	% GE	% PS
PLTW not offered	**	58%	74%
PLTW – Introduction to Engineering	**	20%	5%
PLTW – Principles of Engineering	*	15%	4%
PLTW – Digital Electronics	*	9%	3%
Subject with largest influence on major – Chemistry	***	12%	37%
Subject with largest influence on major – Mathematics	***	43%	23%
Subject with largest influence on major – Other	***	7%	18%
Subject with largest influence on major – Physics	**	19%	7%
Subject with largest influence on major – PLTW	**	11%	3%
Enrolled in a class at a college/ university – Mathematics	*	8%	16%
Enrolled in a class at a college/ university – Social Science	*	8%	16%
Favorite subject(s) in high school – Mathematics	*	79%	67%
Favorite subject(s) in high school – Band	*	11%	16%
Favorite subject(s) in high school – PLTW	*	17%	5%
Participation in programs prior to college – PLTW	**	20%	4%
Participation in programs prior to college – JETS	*	3%	0%
Participation in programs prior to college – None	*	61%	74%

Significant codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05

Table 4.18

Significant Variables by SCCT Category – Social Support and Social Barriers

Variable	Significance	% or µ GE	% or µ PS
Enrolled in Algebra 3	**	11%	22%
Scored a 1 on the AP Calculus BC exam	*	1%	4%
Scored a 1 on the AP Chemistry exam	*	2%	7%
Scored a 2 on the AP Physics B exam	*	0%	3%
Took the AP Physics C (E&M) class, but not exam	*	1%	4%
Took the AP Physics C (Mech) class, but not the exam	***	1%	7%
Took the AP Physics C (Mech) class, and scored a 1	**	0%	4%
Person(s) level of influence on major – Father	***	5.67	4.81
Person(s) level of influence on major – Peers	*	4.94	4.54

Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

Further investigation of the significant variables found that only a small number of respondents indicated the specific variable applied to them. For example, only one percent of the engineering students and only seven percent of the physical science students indicated that they took the AP Physics C (Mech) class, but not the exam. Also, three percent of engineering students and zero percent of the physical science students indicated they participated in the JETS program. While statistically significant, it was determined that these low response variables would not be used in further analysis as they were too small to generalize to a larger population.

Binomial logistic regression was utilized to determine which significantly variables had the largest effect size on the respondents' decision to pursue an engineering degree over a physical science degree. Numerous combinations of variables were tested, with four variables eventually showing large effect size and being simultaneously significant. Table 4.16 illustrates the final binomial regress model.

Table 4.19

Binomial Regression Model Showing Variables which Led Respondents to Enroll in an Engineering Major versus a Physical Science Major

Variable	Est. Std.	Std. Error	P -value	Odds Ratio
(Intercept)	-1.5897	0.5844	**	
Person(s) level of influence on major – Father	0.4272	0.1092	***	1.5
Participation in programs prior to college – PLTW	2.1874	0.6273	***	8.9
Subject with largest influence on major – Mathematics	1.3204	0.3291	***	3.7
Subject with largest influence on major – Physics	1.6498	0.5079	**	5.2

Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

Based upon the results shown in Table 4.19, students who reported that a father's influence was the largest influence over their choice of major were 1.5 times more likely to be engineering majors. Based on this result, a father's influence may play a significant encouraging role in directing students towards engineering. Students who reported that participation in PLTW was the largest influence over their choice of major were 8.9 times more likely to be engineering majors. Based on this result, participation in PLTW may play a significant encouraging role in directing students towards engineering. Students who reported Mathematics was the largest influence over their choice of major were 3.7

times more likely to be engineering majors. Based on this result, a positive Mathematics experience may play a significant encouraging role in directing students towards engineering. Finally, students who reported that Physics was the largest influence over their choice of major were 5.2 times more likely to be engineering majors. Based on this result, a positive Physics experience may play a significant encouraging role in directing students towards engineering. Additionally, a Chi-Square Goodness of Fit Test found a significant difference ($p = 3.077e-12$) between the study model and a null model. The Goodness of Fit Test is used to determine if the observed data fits the statistical model. If the computed test statistic is non-significant, then the model is a poor fit to the data.

Discussion of Findings

The purpose of research question one was to identify and compare demographic characteristics of freshmen engineering and physical science students. This question was derived from the literature which stated there was a shortage and need for engineers. Tables 4.1 through 4.14 illustrated demographic characteristics of the survey respondents.

Males comprised 66% of the engineering survey respondents and 65% of physical science respondents (see Table 4.1). These figures support York's (2008) finding that a significantly greater proportion of males than females planned to enter STEM majors. Data supplied by the Office of Institutional Research at the institution where the survey was conducted indicated that males composed 76% of the first-time Freshmen enrolled in engineering. Gibbons (2011) reported that males received 81.9% of the engineering Bachelor's degrees awarded in 2010. While the percentage of male survey respondents was lower than the national average, the survey population was a more accurate representation of the national population.

Table 4.2 illustrated the race of survey respondents, with the three largest responding groups being Caucasian/White – 86%, African American/Black – 6%, and Asian – 4%. Data supplied by the Office of Institutional Research at the institution where the survey was conducted indicated the racial make-up of first-time Freshman engineering students included Caucasian/White – 84%, African American/Black – 7%, and Asian – 3%. Gibbons (2011) reported that Caucasians/Whites received 69.8% of the engineering Bachelor's degrees awarded in 2010, followed by Asians – 12.2%, and African American/Black 4.5%. The ethnic backgrounds of the survey respondents closely matched that of the survey population; however, the respondents did have some difference from the national population.

The mean SAT composite scores (Critical Reading and Mathematics) of engineering and physical science survey respondents were 1283 and 1302 respectively. The Admissions Office at the survey university reported the mean scores for first-time Freshman engineering and physical science students were 1266 and 1286 respectively. The College Board (2010) reported the mean SAT composite scores, for 2010 college-bound students intending on majoring in engineering, was 1118 and students intending on majoring in the physical sciences was 1146. The mean SAT score for all 2010 college-bound students was 1017. The results of the present survey support Potvin's (et al., 2009) and Nicholl's (et al., 2007) research that engineering students tend to have higher SAT scores.

Table 4.20

Respondents' SAT Scores Compared to Other Populations

Population	Engineering	Physical Science	All
Survey Respondents	1283	1302	-
Sample University Freshmen	1266	1286	1231
2010 College-Bound Seniors	1118	1146	1017

The Composite ACT scores for the respondents were 28 for engineering students and 29 for physical science students. Table 4.21 compares the Composite ACT scores of the respondents against the sample university's freshman engineering and physical science students, the graduating class of 2010 who indicated engineering or physical science as their planned educational major, and the national average for the graduating class of 2010. As with SAT scores, engineering and physical science students tend to have higher ACT scores compared to non-STEM students.

Table 4.21

Respondents' ACT Scores Compared to Other Populations

Population	Engineering	Physical Science	All
Survey Respondents	28	29	-
Sample University Freshmen	29	29	28
2010 College-Bound Seniors	23.2	23.8	21

Survey respondents tended to have higher mean AP scores in the areas of mathematics and sciences than all students who took the same AP exams in May of 2010 (College Board, 2010). These results support Sitaramiah's (2006) research that math and science is key to engineering, Potvin's (et al., 2009) conclusion that engineering students had comprehensive mathematics preparation, and Tyson's (et al., 2007) findings that physics and calculus were important with respect to obtaining a STEM degree. The present findings also support Astin and Astin's (1992) research that mathematical and academic preparations were strong indicators for student interest in engineering disciplines. Table 4.22 illustrates that AP scores of survey respondents with that of all students who took mathematics and science AP exams in May 2010.

Table 4.22

Respondents' AP Scores Compared to All Students' Scores from May 2010

Exam	Engineering	Physical Science	All
Calculus AB	3.73	3.66	2.81
Calculus BC	3.52	4.29	3.86
Chemistry	3.57	3.75	2.76
Physics B	3.75	4.29	2.86
Physics C (Electricity and Magnetism)	3.45	3.83	3.47
Physics C (Mechanics)	3.58	3.88	3.39

Research question two asked what variables have a significant influence on a student's decision to pursue and engineering or physical science degree in college. A total of 29 variables were statistically significant, while four variables were found to substantially predict a student's decision to pursue engineering versus a physical science degree. The four variables which had a significant effect on a student's decision to enroll in engineering versus physical science were: Subject with largest influence on major – Mathematics, Subject with largest on major – Physics, Participation in programs prior to college – PLTW, and Person(s) level of influence on major – Father.

Numerous studies (Moore, 2006; Dick & Rallis, 1991; Potvin, Tai, & Sadler, 2009) have stated the importance the importance of math in preparing a student for a major in engineering or the physical sciences. Results of the present study, that a father's influence, and participation in the subjects of mathematics and physics, reaffirms Moore's (2006) study of African-American males' career trajectory toward pursuing engineering, which found that: (a) strong interests in science, technology, engineering, and mathematics; (b) strong familial influence and encouragement; and (c) strong aptitudes in science and mathematics, all led to said students pursuing engineering in college (p. 250). Finally, Miller's research (as cited in Michigan State University News, 2010) stated "mathematics is the primary gateway to a STEMM career – beginning with algebra track placement in grades seven and eight, and continuing through high school calculus courses."

There was a slight discrepancy between one of the present study's outcomes and the research on parental influence on major choice. While the present found study found that a father's influence led students to pursue an engineering major, many studies (Denson, Avery, & Schell, 2010; Hoffman, St. Louis, & Hoffman, 2010; Walmsley, Wilson, & Morgan; 2010; Wimberly & Noeth, 2004) found that both parents, or only mothers, were highly influential in students' decision to pursue engineering, or other STEM disciplines. Walmsley, Wilson, and Morgan's (2010) research on college major influence found family members played the role of sources of support and information brokers. The same study also noted that parental support had a major impact on what a student decided to pursue as a major. Hoffman, St. Louis, and Hoffman's (2010) study on how parent engineers influenced their daughter's college major choice found that "parental encouragement of their daughters, regardless of the relationship to science, also emerged as an important factor" (p. 243). Additionally, Wimberly and Noeth's (2004) research on postsecondary planning concluded:

> African American and Hispanic high school seniors indicated a strong parental influence on their college planning activities. They perceived their mothers as being a strong influence on their college planning process. More students reported their mothers as being very helpful in their college planning decisions than any other person or college planning factor. Fathers also had a strong influence on students' college plans, but not to the same extent as mothers (p. 6).

The results of the present study generally agree with the previous studies; however, findings from the current study showed a father's influence had a differential impact among family members; for students who chose to pursue engineering a father's influence was particularly important. The present study also confirmed that mathematics and physics influenced a student to pursue an engineering major. Finally, the present study supports the fact that participation in PLTW encourages to pursue engineering at the college level. However, it should be noted that students who participate in PLTW may self-select to be in the program, and these students may have already decided to pursue engineering in college. The results of this study add to, and reinforce the existing literature on the topic of major selection in STEM disciplines.

Chapter Summary

The study population consisted of all first-year engineering and physical science students at enrolled at a large, four-year, research university in the southeastern United States. The High School Activities, Characteristics, and Influences Survey was administered to 1,075 students freshmen enrolled on general engineering or physical science majors. 413 general engineering and physical science students responded to the survey, yielding a response rate of 38%.

Research question one asked what are the demographic characteristics of students entering a freshmen engineering program. The majority of the students were male. Out of 413 respondents, 66% (n = 273) identified themselves as male and 34% (n = 140) identified themselves as female. Regarding race, 86% (n = 294) of the engineering students were Caucasian/ White, while 85% (n = 61) of the physical science students were Caucasian/ White. All other race groups had less than 8% of the population in either engineering or physical science. English was the primary language for 93% (n = 385) of the respondents. The average SAT score for engineering students was 614 on Critical Reading and 669 on Mathematics, while physical science students averaged 634 on

Critical Reading and 668 on Mathematics. The Composite ACT score for engineering students was 28 and physical science students had a 29.

In-State students were a majority of the sample population with 63% (n = 215) engineering being in-state and 75% (n = 54) of physical science students being in-state. Only 36% (n = 122) and 24% (n = 17) of engineering and physical science students were out-of-state, respectively. International students composted just 1% of both engineering and physical science students. Half (52%) of the female parent/ guardians of engineering students highest level of education was a Bachelor's degree, while 38% of the science students' female parent/ guardian had a Bachelor's degree as their highest level of education. Respondents indicated 43% of engineering students' male parent/ guardians had a Bachelor's degree as their highest level of education, while 29% of physical science students' male parent/ guardians had a Bachelor's degree as their highest level of education. Complete degree levels are found in Tables 4.7 and 4.8.

Tables 4.9 through 4.14 illustrated engineering and physical science students' school offering, participation, and scores on the AP subjects of Calculus AB, Calculus BC, Chemistry, Physics B, Physics C (Electricity and Magnetism), and Physics C (Mechanics). There were no significant differences in offerings, participation, or test scores between engineering and physical science students. The mean household income for engineering students was $49,900 and $49,987 for physical science students.

Research question two asked what variables have a significant influence on a student's decision to pursue an engineering or physical science degree in college. A Wilcoxon test found 29 of the 277 variables collected in the survey to be significantly different (p-value < .05). Binomial logistic regression was utilized to determine which variables had the largest effect size on the respondents' decision to pursue and engineering degree over a physical science degree. A father's influence is 1.5 times more likely to lead a high school student to enroll in an engineering major over a physical science major. Participation in PLTW is 8.9 times likely to influence a student enroll in an engineering major over a physical science major. Finally, the subject Mathematics was 3.7 times more likely to influence a student to enroll in an engineering major and the subject Physics was 5.2 more times to do the same. Additionally, a Chi-Square Goodness of Fit Test found a significant difference (p = 3.077e-12) between the study model and a null model.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

Introduction

The purpose of this study was to investigate what variables have a significant impact on a high school student's decision to pursue an engineering or physical science degree in college. The study compared students who were freshmen in an engineering or physical science major at an institution in the Southeastern United States. An introduction to the study, review of the literature, methodology, summary of the findings have been presented. The content of this chapter will be discussed under the following sections: a) summary of findings, (b) conclusion, (c) limitations, (d) implications for theory, policy, and practice, and (e) suggestions for future research.

Summary of the Findings

The study population consisted of all first-year engineering and physical science students at enrolled at a large, four-year, research university in the southeastern United States. The High School Activities, Characteristics, and Influences Survey was administered to 1,075 students freshmen enrolled in general engineering or physical science majors. Four hundred thirteen general engineering and physical science students responded to the survey, yielding a response rate of 38%.

Research question one asked what are the demographic characteristics of students entering a freshmen engineering program. The majority of the students were male. Out of 413 respondents, 66% (n = 273) identified themselves as male and 34% (n = 140) identified themselves as female. Regarding race, 86% (*n* = 294) of the engineering students were Caucasian/ White, while 85% (*n* = 61) of the physical science students were Caucasian/ White. All other race groups had less than 8% of the population in either engineering or physical science. English was the primary language for 93% (*n* = 385) of the respondents. The average SAT score for engineering students was 614 on Critical Reading and 669 on Mathematics, while physical science students averaged 634 on Critical Reading and 668 on Mathematics. The Composite ACT score for engineering students was 28 and physical science students had a 29.

In-State students were a majority of the sample population with 63% (*n* = 215) engineering being in-state and 75% (*n* = 54) of physical science students being in-state. Only 36% (*n* = 122) and 24% (*n* = 17) of engineering and physical science students were out-of-state, respectively. International students composed only 1% of both engineering and physical science students. Half (52%) of the female parent/ guardians of engineering students highest level of education was a Bachelor's degree, while 38% of the science students' female parent/ guardian had a Bachelor's degree as their highest level of education. Respondents indicated 43% of engineering students' male parent/ guardians had a Bachelor's degree as their highest level of education, while 29% of physical science students' male parent/ guardians had a Bachelor's degree as their highest level of education. Complete degree levels are found in Tables 4.7 and 4.8.

Tables 4.9 through 4.14 illustrated engineering and physical science students' school offering, participation, and scores on the AP subjects of Calculus AB, Calculus BC, Chemistry, Physics B, Physics C (Electricity and Magnetism), and Physics C

(Mechanics). There were no significant differences in offerings, participation, or test scores between engineering and physical science students. The mean household income for engineering students was $49,900 and $49,987 for physical science students.

Research question two asked what variables have a significant influence on a student's decision to pursue an engineering or physical science degree in college. A Wilcoxon test found 29 of the 277 variables collected in the survey to be significant (p-value < .05). Binomial logistic regression was utilized to determine which significantly variables had the largest effect size on the respondents' decision to pursue and engineering degree over a physical science degree. A father's influence is 1.5 times more likely to lead a high school student to enroll in an engineering major over a physical science major. Participation in PLTW is 8.9 times likely to influence a student enroll in an engineering major over a physical science major. Finally, the subject Mathematics was 3.7 times more likely to influence a student to enroll in an engineering major and the subject Physics was 5.2 more times to do the same. Additionally, a Chi-Square Goodness-of-Test found a significant difference (p = 3.077e-12) between the study model and a null model.

Conclusion

While numerous variables similarly influenced both engineering and physical science students to pursue their respective majors, the present study produced three significant findings from which practitioners and researcher can utilize. First, the study found that a student's father is the person with the most differential influence on a student's decision to enroll in an engineering major versus a physical science major.

According to the study, the father/ male guardian had more influence than: mother/ female guardian, sibling(s), other relative(s), peers, high school math teacher(s), high school chemistry teacher, other high school teachers, or high school guidance counselor.

Second, the present study concluded that the subjects of mathematics and physics influenced high school students to enroll in an engineering major, more so than they did to have the same students to enroll in a physical science major. In fact, the subject of mathematics had over three times the influence to lead a student to enroll in an engineering major versus a physical science major, while the subject of physics had over five times the influence to lead a student to enroll in an engineering major versus a physical science major. Finally, the results of the study concluded that students are more influenced to enroll in an engineering major versus a physical science major if they participate in Project Lead the Way while in high school.

Limitations

There were four primary limitations to the present study. Data for the study was collected by surveying first-year engineering and physical science students at a large, four-year, research university in the southeastern United States. First, the survey was administered at a single institution. If the survey been administered at multiple locations there may have been more variance in the demographic responses. Additionally, if the survey had been administered at different types of institutions (i.e. HBCU, single-gender, private, or community college), different or additional significant factors may have been found. For example, Table 4.1 indicated that 66% of the respondents were male and Table 4.2 indicated that 86% of the respondents were Caucasian/ White. Based on these results, the majority of the survey population were White/ Caucasian males. Different data may have resulted if the majority of the survey population was non-White/ Caucasian (HBCU or Tribal College) and/ or female (single-gender women's college).

Second, the survey only collected data from one cohort of students at single point in time. Multiple years of data would reinforce, or revise, results from the present study. As the economy changes, perceptions of STEM disciplines change, course offerings change in high schools, and other factors influence students' decision to purse STEM majors, it is possible that findings of the High School Activities, Characteristics, and Influences Survey will vary from year-to-year and location-to-location. Additional surveys will aid in validating the results of the current study.

Third, 65% of the respondents identified themselves as in-state. These students were required to follow the curriculum guidelines set by their state, and may not have had the same educational opportunities of students from other states. More so, the educational opportunities of the in-state students varied by school district, private school governance, and home-schooling regulations. A more diverse sample population, which includes larger numbers of out-of-state and international students, will provide a better representation of high school course offerings, student interests, household incomes, parental educational levels, and social supports/ barriers. Finally, the present study used 2000 Census data, as 2010 Census data was not available at the time of data analysis. The use of 2000 data only affected the analysis of mean household income.

Implications for Theory, Policy, and Practice

Implications for Theory

This study used Lent et al.'s (1994) Social Cognitive Career Theory (SCCT) to develop the survey questions which helped measure the influence different variables had on a student's decision to pursue a major in engineering or physical science. Questions for the survey fell under the SCCT categories of interests, outcome expectations, self-efficacy, and social support and barriers. These five categories of variables lead to the student's major choice goal, or decision to pursue engineering or physical science.

The survey results do support Lent et al.'s theory that the five SCCT categories lead students to their major choice goal. However, it should be noted, that most of the significant differences between engineering and physical science students fell under the categories of interests (see Table 4.17) and social supports and barriers (see Table 4.18). These two categories accounted for 26 of the 29 variables deemed significantly different during the statistical analysis. Based on these results, it is evident that the SCCT categories of interest and social support/ barriers have the most influence on a student's decision to pursue an engineering or physical science degree. Furthermore, of the four variables that differentially led students to enroll in an engineering major versus a physical science major, three of the variables were under the SCCT category of interests and one was in the category of social supports and barriers (see Table 4.19).

Implications for Policy and Practice

As stated in the review of the literature, there is a need for more engineers that affects several industries. Based upon the literature review and findings from the present study, policies must be updated, or created, at several different agencies and entities to increase the number of college freshman entering engineering disciplines. To increase the number of student entering engineering majors, policies should be evaluated at the school level, school districts, higher education institutions, industry, and the state and federal government.

At the school level, middle school and high school leaders should develop a policy which seeks to identify students who have the aptitude and ability to excel at mathematics and science. A successful policy will aid in placing future engineering students into the pipeline to eventually enroll in Calculus and Physics in particular. A school district-wide policy which requires high schools to offer higher level mathematics and physics courses will mean students, regardless of where they attend school, will have access to the classes which will prepare them for an engineering degree. Additionally, a district-wide policy should require schools to incorporate career guidance as part of the academic curriculum. A district-wide policy will ensure no student is penalized for attending any particular school.

Leaders at higher education institutions should develop policies which promote careers in engineering to middle and high school students, aid in recruiting students with high aptitude for math and science, and develop relationships with industry to connect engineering majors to future employers. In turn, industries should develop policies which involve outreach programs to middle and high school students with engineering aptitudes, scholarship support for engineering undergraduates, and encourage partnerships with undergraduate engineering programs. Finally, state and federal government leaders should develop policies which give incentives for students to pursue an undergraduate engineering degree.

Policies should not be created independently, but should be developed with input by a team of leaders from the stated agencies and entities. This team of leaders should work together to devise a better, consistent, way to attract, educate, and move future engineers into the workforce. By working together these policies can be put into practice and increase the number of engineers entering the workforce.

The results of this study identified factors which will aid in putting policies into practice. First, enrollment in mathematics and physics were predictors of enrollment in engineering. Results from the survey showed that both engineering and physical science students determined their future college major when they were in the tenth to eleventh grade; therefore, practices must be in place prior to the Junior year of high school to attract students into engineering. As early as possible, school districts and individual schools should identify those students who have a strong ability and aptitude for math and science. Not only for these students, but for all students, math and science should be made fun and exciting - bad math attitudes should not be passed on. Identifying students with engineering aptitude should be accomplished by early middle school, as many students have the opportunity to begin high school level math in the seventh or eighth grade. By enrolling in advanced math classes while still in middle school, these students will then have the opportunity to take Advanced Placement or college-level math and physics classes towards the end of their high school years.

If needed, additional well-trained math and science educators should be placed into schools. This level of commitment will need to be supported by both state and federal governments, as well as industry. Programs, such as the state of South Carolina's Program of Alternative Certification for Educators (PACE) program, enables "degreed individuals, who otherwise do not meet certification requirements, to gain employment in the public schools in a content area included in the alternative certification program" (2011). The PACE program satisfies two issues regarding mathematics and physics being taught in public schools: showing real-world applications of curriculum and it adds to the pool of teachers with the necessary skills. PACE places qualified individuals with real-world experience into the classroom. The PACE teachers can also help bridge the gap between instruction and informing students of the practical applications of mathematics and physics. There are schools that do not offer high level mathematics courses or any physics courses at all due to a lack of qualified teachers; an infusion of qualified PACE teachers can bring such courses to these schools and districts.

Institutions of higher education and industry must coordinate with school districts (or the state governing education agency) to discuss math and science curricula and verify said curricula are preparing students for the rigors of college engineering programs. By having a clear understanding what industry requires, what universities and colleges are teaching, K-12 schools know what and how to teach future engineers. Coordination and cooperation among these entities will help ensure a consist flow of qualified engineers entering the profession.

Participation in Project Lead the Way was found to be a heavy influence on students to pursue engineering versus physical science in the present survey (see Table 4.19). The PLTW program provides an excellent example of how schools, districts, higher education, and industry can work together to attract, educate, and move future engineers into the workforce. The PLTW network is comprised of several groups: corporate and philanthropic sponsors, master teachers, PLTW staff, PLTW teachers, partners, partnership teams, STEM associations and organizations, school counselors, school district delegates, state leaders, and university affiliates (PLTW, 2010). A network, similar to that of the PLTW network, should be developed with an emphasis on physics and mathematics.

Finally, a father's influence was found to be significant variable in a student's decision to pursue an engineering versus a physical science major. Career programs, typically organized by the schools' guidance counselors or career specialists, should not only involve students, but should also include the father's participation. As noted earlier, parental influence does play a part in course and major selection. In addition to parents attending school sponsored career fairs, industry should sponsor open houses that include both students and parents to attend. These industry open houses should paint a picture of how math and physics can lead to a rewarding career in engineering.

Suggestions for Future Research

While the findings from this study provided a better understanding of what influences a student to pursue engineering instead of a physical science degree in college, two suggestions for future research were identified based upon the current study. These suggestions were based upon the methods and populations sampled in the current study.

Recommendation One: Expand survey to include additional institutions.

As noted in the limitations section of this chapter, the survey was administered at a single institution. Future research examining influences leading to engineering or physical science majors should incorporate data from multiple institutions. These institutions should include community colleges, private institutions, small institutions, HBCU's and other institutions with high minority enrollments, single-gender institutions, and out-of-state institutions. By expanding the survey to different institution types, the data collected should represent a population with greater diversity. The population in the present study was composed primarily of White, in-state males.

Recommendation Two: Conduct a similar study to include humanities/ social science students.

The present study sought to uncover the variables which influenced a student to pursue an engineering or physical science major. Future research should survey a population of students majoring in humanities/ social sciences to see what variables influenced them to pursue their respective majors. Once that research is complete, a comparison between the engineering/ physical science and humanities/ social science should be conducted to determine if the two populations' major choice are influenced by similar variables.

APPENDICES

Appendix A

Research Compliance Approval

Dear Dr. Satterfield,

The Chair of the Clemson University Institutional Review Board (IRB) validated the protocol identified above using Exempt review procedures and a determination was made on **July 7, 2010**, that the proposed activities involving human participants qualify as Exempt from continuing review under Category **B2**, based on the Federal Regulations (45 CFR 46). You may begin this study.

Please remember that the IRB will have to review all changes to this research protocol before initiation. You are obligated to report any unanticipated problems involving risks to subjects, complications, and/or any adverse events to the Office of Research Compliance (ORC) immediately.

We also ask that you notify the ORC when your study is complete or if terminated.

Please review the Responsibilities of Principal Investigators (available at http://www.clemson.edu/research/compliance/irb/regulations.html) and the Responsibilities of Research Team Members (available at http://www.clemson.edu/research/compliance/irb/regulations.html) and be sure these documents are distributed to all appropriate parties.

Good luck with your study, and let us know if you have any questions. Please use the IRB number and title in all communications regarding this study.

All the best,
Nalinee
Nalinee D. Patin

IRB Coordinator
Clemson University
Office of Research Compliance
Institutional Review Board (IRB)
Voice: (864) 656-0636
Fax: (864) 656-4475
Web site: http://www.clemson.edu/research/compliance/irb/

Appendix B

High School Activities, Characteristics and Influences Survey

High School Activities, Characteristics, and Influences Survey

Consent Form for Participation in a Research Study at Clemson University

AN EXAMINATION OF CHARACTERISTICS WHICH INFLUENCE HIGH SCHOOL STUDENTS TO ENROLL IN AN UNDERGRADUATE ENGINEERING MAJOR

Description of the research and your participation

You are invited to participate in a research study conducted by James W. Satterfield and Christopher H. Porter. The purpose of this research is to uncover what activities, characteristics, and influences you encountered in high school which may have led you to pursue your current major at Clemson University.

Your participation will involve completing a 64-item online survey and is completely anonymous. The survey will take approximately 15 minutes to complete.

Risks and discomforts

There are no known risks associated with this research.

Potential benefits

There are no known benefits that would result from your participation in this research. This research may help us to understand why students enroll in an undergraduate engineering program.

Protection of confidentiality

All information used and recorded for this study will be protected to ensure participant confidentiality. We will do everything we can to protect your privacy. All records will be kept on a password-protected computer of the investigator. Your identity will not be revealed in any publication that might result from this study. We request that all participants of the study to respect the confidentiality and privacy of others known to take part in the study.

Voluntary participation

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study. You may not participate in this survey if you are under the age of 18.

The survey will be available until 12:00pm September 10, 2010.

Incentive

Students who participate in the survey and wish to be considered for a drawing for a Best Buy $50 gift card will need to enter their e-mail address on the survey form. Three gift certificates will be awarded.

Contact information

If you have any questions or concerns about this study or if any problems arise, please contact James W. Satterfield at Clemson University at 864-656-5111 or Chris Porter at 864-656-7870. If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Institutional Review Board at 864-656-6460.

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High School Activities, Characteristics, and Influences Survey

1. Do you consent to taking this survey?

- ◯ Yes
- ◯ No

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High School Activities, Characteristics, and Influences Survey

2. As of today, are you 18 years old or older?

- ◯ Yes
- ◯ No

High School Activities, Characteristics, and Influences Survey

3. What is your current age?

4. What year did you graduate high school?

5. What year did you first enroll at Clemson University?

6. What is your current major at Clemson University?

7. If you have a second major (double-majoring), please indicate it

8. What degree do you plan to graduate with?

9. If you indicated "other," please list the degree to plan to graduate with

10. What do you plan to do after you complete your undergraduate education?

11. Please indicate all of the math courses you completed for high school credit

- [ ] I did not take Math in high school
- [ ] I took another Math not listed
- [ ] Algebra 1
- [ ] Algebra 2
- [ ] Algebra 3
- [ ] Geometry
- [ ] Trigonometry
- [ ] Pre-Calculus
- [ ] Statistics or Probability and Statistics
- [ ] AP Statistics or AP Probability and Statistics
- [ ] Discrete Mathematics
- [ ] AP Calculus AB
- [ ] AP Calculus BC
- [ ] IB Calculus

High School Activities, Characteristics, and Influences Survey

12. Please indicate all of the science courses you completed for high school credit

- [ ] I did not take a Science in high school
- [ ] I took another Science not listed
- [ ] Physical Science
- [ ] Chemistry Honors Chemistry
- [ ] AP Chemistry
- [ ] IB Chemistry
- [ ] Biology
- [ ] Honors Biology
- [ ] AP Biology
- [ ] IB Biology
- [ ] Physics
- [ ] Honors Physics
- [ ] AP Physics B
- [ ] AP Physics C (Mechanics)
- [ ] AP Physics C (Electricity and Magnetism)
- [ ] IB Physics

13. What other Advanced Placement (AP) classes did you complete in high school?

- [ ] AP not offered at my school
- [ ] AP offered at my school, but I did not participate
- [ ] Art History
- [ ] Art: Studio Art Drawing
- [ ] Art: Studio Art-2D Design
- [ ] Chinese Language and Culture
- [ ] Computer Science A
- [ ] Computer Science AB
- [ ] Environmental Science
- [ ] European History
- [ ] French Language
- [ ] French Literature
- [ ] German Language
- [ ] Government and Politics: Comparative
- [ ] Government and Politics: United States
- [ ] Human Geography
- [ ] International English Language
- [ ] Italian Language and Culture
- [ ] Japanese Language and Culture
- [ ] Language and Composition
- [ ] Latin
- [ ] Literature and Composition
- [ ] Macroeconomics
- [ ] Microeconomics
- [ ] Music Theory
- [ ] Psychology
- [ ] Spanish Language
- [ ] Spanish Literature
- [ ] United States History
- [ ] World History

High School Activities, Characteristics, and Influences Survey

14. Did you take the AP Biology Exam?

- AP Biology was not offered at my school
- AP Biology was offered at my school, but I did not participate
- I took the AP Biology class, but not the exam
- Yes, and I made a 1
- Yes, and I made a 2
- Yes, and I made a 3
- Yes, and I made a 4
- Yes, and I made a 5

15. Did you take the AP CALCULUS AB Exam?

- AP Calculus AB was not offered at my school
- AP Calculus AB was offered at my school, but I did not participate
- I took the AP Calculus AB class, but not the exam
- Yes, and I made a 1
- Yes, and I made a 2
- Yes, and I made a 3
- Yes, and I made a 4
- Yes, and I made a 5

16. Did you take the AP CALCULUS BC Exam?

- AP Calculus BC was not offered at my school
- AP Calculus BC was offered at my school, but I did not participate
- I took the AP Calculus BC class, but not the exam
- Yes, and I made a 1
- Yes, and I made a 2
- Yes, and I made a 3
- Yes, and I made a 4
- Yes, and I made a 5

High School Activities, Characteristics, and Influences Survey

17. Did you take the AP CHEMISTRY Exam?

- ◯ AP Chemistry was not offered at my school
- ◯ AP Chemistry was offered at my school, but I did not participate
- ◯ I took the AP Chemistry class, but not the exam
- ◯ Yes, and I made a 1
- ◯ Yes, and I made a 2
- ◯ Yes, and I made a 3
- ◯ Yes, and I made a 4
- ◯ Yes, and I made a 5

18. Did you take the AP PHYSICS B Exam?

- ◯ AP Physics B was not offered at my school
- ◯ AP Physics B was offered at my school, but I did not participate
- ◯ I took the AP Physics B class, but not the exam
- ◯ Yes, and I made a 1
- ◯ Yes, and I made a 2
- ◯ Yes, and I made a 3
- ◯ Yes, and I made a 4
- ◯ Yes, and I made a 5

19. Did you take the AP PHYSICS C (ELECTRICITY AND MAGNETISM) Exam?

- ◯ AP Physics C (Electricity and Magnetism) was not offered at my school
- ◯ AP Physics C (Electricity and Magnetism) was offered at my school, but I did not participate
- ◯ I took the AP Physics C (Electricity and Magnetism) class, but not the exam
- ◯ Yes, and I made a 1
- ◯ Yes, and I made a 2
- ◯ Yes, and I made a 3
- ◯ Yes, and I made a 4
- ◯ Yes, and I made a 5

20. Did you take the AP PHYSICS C (MECHANICS) Exam?

- ◯ AP Physics C (Mechanics) was not offered at my school
- ◯ AP Physics C (Mechanics) was offered at my school, but I did not participate
- ◯ I took the AP Physics C (Mechanics) class, but not the exam
- ◯ Yes, and I made a 1
- ◯ Yes, and I made a 2
- ◯ Yes, and I made a 3
- ◯ Yes, and I made a 4
- ◯ Yes, and I made a 5

21. Did you participate in an International Baccalaureate (IB) program at your high school?

22. Please indicate your highest score on the SAT MATH SUBTEST. For example: 780, 540, 450; if you did not take the SAT, enter "Did not take the SAT."

23. Please indicate your highest score on the SAT CRITICAL READING SUBTEST. For example: 780, 540, 450; if you did not take the SAT, enter "Did not take the SAT."

24. Please indicate your highest score on the SAT WRITING SUBTEST. For example: 780, 540, 450; if you did not take the SAT, enter "Did not take the SAT."

25. Please indicate your highest ACT COMPOSITE SCORE. For example: 34, 29, 18; if you did not take the ACT, enter "Did not take the ACT."

26. Please indicate your highest score on the ACT ENGLISH SUBTEST. For example: 34, 29, 18; if you did not take the ACT, enter "Did not take the ACT."

27. Please indicate your highest score on the ACT MATH SUBTEST. For example: 34, 29, 18; if you did not take the ACT, enter "Did not take the ACT."

28. Please indicate your highest score on the ACT READING SUBTEST. For example: 34, 29, 18; if you did not take the ACT, enter "Did not take the ACT."

High School Activities, Characteristics, and Influences Survey

29. Please indicate your highest score on the ACT SCIENCE SUBTEST. For example: 34, 29, 18; if you did not take the ACT, enter "Did not take the ACT."

30. Please indicate your highest score on the ACT WRITING SUBTEST. For example: 34, 29, 18; if you did not take the ACT, enter "Did not take the ACT."

31. Did you attend science/ math/ engineering camps while in high school?

- No
- Yes

32. Please indicate which Project Lead The Way (PLTW) classes you were enrolled in while in high school

- Project Lead The Way was not offered at my school
- Project Lead The Way was offered at my school, but I did not participate
- Introduction to Engineering Design
- Principles of Engineering
- Digital Electronics
- Aerospace Engineering
- Biotechnical Engineering
- Civil Engineering and Architecture
- Computer Integrated Manufacturing
- Engineering Design and Development
- Principles of the Biomedical Sciences
- Human Body Systems
- Medical Interventions
- Biomedical Innovation

33. What subject had the largest influence on you pursuing your current major?

34. Indicate your level of confidence in your ability to SOLVE PROBLEMS

1 - Not Confident | 2 | 3 | 4 | 5 | 6 | 7 - Very Confident

35. Indicate your level of confidence in your ability to SOLVE PROBLEMS WHILE WORKING ALONE

1 - Not Confident | 2 | 3 | 4 | 5 | 6 | 7 - Very Confident

High School Activities, Characteristics, and Influences Survey

36. Indicate your level of confidence in your ability to SOLVE COMPLEX MATH PROBLEMS

◯ 1 - Not Confident ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 - Very Confident

37. Indicate your level of confidence in your ability to BE CREATIVE

◯ 1 - Not Confident ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 - Very Confident

38. Indicate your level of confidence in your ability to WORK ON A TEAM

◯ 1 - Not Confident ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 - Very Confident

39. Indicate your level of confidence in your ability to COMMUNICATE EFFECTIVELY

◯ 1 - Not Confident ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 - Very Confident

40. Indicate your level of confidence in your ability to HAVE ATTENTION TO DETAIL

◯ 1 - Not Confident ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 - Very Confident

41. Did you enroll in classes through a college or university while in high school; if so, check all that apply.

- [ ] I did not enroll in classes through a college or university while in high school
- [ ] Engineering
- [ ] Mathematics
- [ ] Chemistry
- [ ] Biology
- [ ] Physics
- [ ] Other Science
- [ ] English
- [ ] Social Science
- [ ] Other Non-Science

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42. How important were the following criteria in your decision to pursue your current major?

	1 - Not Important	2	3	4	5	6	7 - Very Important
Developing new knowledge and skills	◯	◯	◯	◯	◯	◯	◯
Becoming well known	◯	◯	◯	◯	◯	◯	◯
Having others work under my supervision	◯	◯	◯	◯	◯	◯	◯

43. Please indicate all of your family members who are employed in an engineering/ science profession.

- ☐ I have no family members who are employed in an engineering/ science profession.
- ☐ Mother/ Female Guardian
- ☐ Father/ Male Guardian
- ☐ Aunt
- ☐ Uncle
- ☐ Grandmother
- ☐ Grandfather
- ☐ Sibling

44. Rate the level of influence the following person(s) had on your decision to pursue your current major.

	Strong Negative	2	3	Neutral	5	6	Strong Positive	Not applicable
Mother/ Female Guardian	◯	◯	◯	◯	◯	◯	◯	◯
Father/ Male Guardian	◯	◯	◯	◯	◯	◯	◯	◯
Sibling(s)	◯	◯	◯	◯	◯	◯	◯	◯
Other Relative(s)	◯	◯	◯	◯	◯	◯	◯	◯
Peers	◯	◯	◯	◯	◯	◯	◯	◯
High School Math Teacher (s)	◯	◯	◯	◯	◯	◯	◯	◯
High School Chemistry Teacher	◯	◯	◯	◯	◯	◯	◯	◯
High School Other Teachers	◯	◯	◯	◯	◯	◯	◯	◯
High School Guidance Counselor	◯	◯	◯	◯	◯	◯	◯	◯

45. In what grade did you decide you wanted to pursue your current major?

☐

High School Activities, Characteristics, and Influences Survey

46. While in high school, did you job shadow a person who works as an engineer, scientist, or mathematician?

47. How important were the following criteria in your decision to pursue your current major?

	1 - Not Important at All	2	3	4	5	6	7 - Very Important
Helping other people	◯	◯	◯	◯	◯	◯	◯
Making money	◯	◯	◯	◯	◯	◯	◯
Job security	◯	◯	◯	◯	◯	◯	◯

48. How important were the following criteria in your decision to pursue your current major?

	1 - Not Important	2	3	4	5	6	7 - Very Important
Inventing new things	◯	◯	◯	◯	◯	◯	◯
Making your own decisions	◯	◯	◯	◯	◯	◯	◯
Making use of your talents and abilities	◯	◯	◯	◯	◯	◯	◯

49. Rate the level of support your home environment had towards your current major.

◯ Strong Negative ◯ 2 ◯ 3 ◯ Neutral ◯ 5 ◯ 6 ◯ Strong Positive

50. How important were the following criteria in your decision to pursue your current major?

	1 - Not Important	2	3	4	5	6	7 - Very Important
Working in an area with lots of job opportunities	◯	◯	◯	◯	◯	◯	◯
Working with people, rather than objects	◯	◯	◯	◯	◯	◯	◯
Having an exciting job	◯	◯	◯	◯	◯	◯	◯

51. How many times did you visit science/ math/ engineering museums while still in high school?

High School Activities, Characteristics, and Influences Survey

52. What was your favorite subject(s) in high school? Please check all that apply.

- [ ] Mathematics
- [ ] Chemistry
- [ ] Biology
- [ ] Physics
- [ ] English
- [ ] Band
- [ ] Project Lead The Way or other Engineering
- [ ] Social Studies
- [ ] History
- [ ] Foreign Language
- [ ] Physical Education
- [ ] Other

53. Did you participate in high school science fairs?

54. Did you regularly watch science/ engineering television shows prior to enrolling in college? For example: Mythbusters, Megamachines, NOVA, How It's Made?...

55. Did you regularly read science/ engineering magazines prior to enrolling in college? For example: Popular Mechanics, Popular Science, National Geographic, Science, Discover...

56. Please indicate each of the programs you participated in prior to enrolling in college.

- [ ] MathCounts
- [ ] Gateway to Technology
- [ ] Project Lead The Way (PLTW)
- [ ] Junior Engineering Technical Society (JETS)
- [ ] Foundation for the Inspiration and Recognition of Science and Technology (FIRST)
- [ ] Southeastern Consortium for Minorities in Engineering (SECME)
- [ ] None of the above

High School Activities, Characteristics, and Influences Survey

57. What was the biggest influence that caused you to pursue your current major?

58. What types of activities did you enjoy doing while in high school?

59. What do you expect your degree to do for you once you graduate?

60. In what state did you complete high school?

61. If you indicated "International," please enter the country where you completed high school.

62. Please enter the 5-digit zip code of the high school you attended prior to enrolling in Clemson University?

63. What is your gender?

- Female
- Male

64. What is your race?

65. Are you of Hispanic origin?

66. Was English the primary language spoken in your household?

67. What was the highest level of education for your parent/ guardian?

	Less than High School Diploma	High School Diploma/ GED	Some College/ Associate Degree	Bachelor's Degree	Master's Degree or Ph.D.	Professional Degree (Medical, Dental, Legal)	Not applicable
Male parent/ guardian							
Female parent/ guardian							

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High School Activities, Characteristics, and Influences Survey

68. If you wish to enter a drawing for one of three $50 Best Buy gift cards, please enter your Clemson e-mail address below.

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High School Activities, Characteristics, and Influences Survey

I'm sorry, but you must be at least 18 years old to participate in this survey.

Please exit this survey by closing your browser.

Thank you.

High School Activities, Characteristics, and Influences Survey

If wish to consent and participate at a later date, this survey will be available until September 7, 2010.

Thank you

High School Activities, Characteristics, and Influences Survey

Thank you for your time.

Have a great Fall semester.

REFERENCES

American Society for Engineering Education. (2007). *ASEE engineering k12 center*. Retrieved June 24, 2009, from http://www.engineeringk12.org/about/default.php

Anderson, M. (2008, February). *Help wanted: Embedded engineers. Why the United States is losing its edge in embedded systems.... ieee-usa today's engineer online*. Retrieved June 28, 2009, from http://www.todaysengineer.org/2008/Feb/help-wanted.asp

Astin, A.W. & Astin, H.S. (1992). *Final report: Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences*. Higher Education Research Institute, Graduate School of Education, UCLA.

Baine, C. (2003). *Is there an engineer inside you? A comprehensive guide to career decisions in engineering* (2nd ed.). Eugene, OR: Bonamy.

Baine, C. (2009). *Engineers make a difference.* Springfield, OR: Engineering Education Service Center.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1999). Social cognitive career theory of personality. In L. Pervin & O. John (Eds.), *Handbook of personality* (2nd ed., pp. 154-196). New York: Guilford Press.

Bandura, A. (2000). Exercise of human agency through collective efficacy. *Current Directions in Psychological Science, 9,* 75-78.

Barton, P.E. (2002). *Meeting the need for scientists, engineers, and an educated citizenry in a technological society*. Princeton, NJ: Educational Testing Service.

Bernstein, J. (2009, June 4). Can LI schools fill need for engineers? *Newsday*. Retrieved June 28, 2009, from http://www.newsday.com/business/ny-bzbern0412809535jun03,0,2127144,print.story

Berrigan, C.L. (2007, November 6). *Testimony for the record. U.S. Senate Committee on Energy and Natural Resources.* Washiongton, D.C.

Boersma, P. (2010). *The Wilcoxon two sample test. Phonetic Sciences, University of Amsterdam.* Retrieved February 26, 2011, from http://www.fon.hum.uva.nl/Service/Statistics/Wilcoxon_Test.html

Brown, J.L. (2005, July). Wanted: Civil engineers. *Civil Engineering*. 46-49.

California Polytechnic State University. (2009). *E.P.I.C. (engineering possibilities in college)*. Retrieved June 22, 2009, from http://epic.calpoly.edu/about/

Clemson University. (2009). *Summer science, engineering and architecture*. Retrieved July 2, 2009, from http://www.clemson.edu/summer/summer-science/

College Board. (2010). *2010 college-bound seniors total group profile report*. Retrieved September 28, 2011, from http://professionals.collegeboard.com/profdownload/2010-total-group-profile-report-cbs.pdf

College Board. (2010). *Student score distributions*. Retrieved September 28, 2011, from http://professionals.collegeboard.com/profdownload/Student-Score-Distributions-2010.pdf

College Board. (2011). *Physics B*. Retrieved August 28, 2011, from http://www.collegeboard.com/student/testing/ap/sub_physb.html

College Board. (2011). *Physics C*. Retrieved August 28, 2011, from http://www.collegeboard.com/student/testing/ap/sub_physc.html?physicsc

Control Engineering. (2005). *Engineers, scientists, skilled production workers missing in action. 52*(12), 24-27.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CS: Sage Publications.

Cross, S.E. (2001). Training the scientists and engineers of tomorrow. A person-situation approach. *Journal of Applied Social Psychology*, *31*, 296-323.

Denson, C.D., Avery, Z.K. & Schell, J.W. (2010). Critical inquiry into urban African-American students' perceptions of engineering. *Journal of African-American Studies*, *14*, 61-74.

Dillman, D. A. (2007). *Mail and internet surveys: The tailored design method.* New York: J. Wiley.

Engineer.net. (2009, January 8). Gov. Schwarzenegger announces 2008 proposal to bring 20,000 new engineers to California's workforce. *Engineer.net*. Retrieved June 28, 2009, from http://www.engineer.net/engineerarnold.php

Foundation for the Inspiration and Recognition of Science and Technology. (n.d.). *Vision and mission.* Retrieved August 15, 2009, from http://www.usfirst.org/aboutus/content.aspx?id=34

Freeman, S., Jaeger, B., & Whalen, R. (2009, June). *When the light goes on: Illuminating the pathway to engineering.* Paper presented at the meeting of the American Society for Engineering Education, Austin, TX.

Gibbons, M.M., & Shofner, M.F. (2004). Prospective first-generation college students: Meeting their needs through social cognitive career theory. *Professional School Counseling, 8*(1), 91-97.

Gibbons, M.T. (2011). *Engineering by the numbers*. Retrieved September 27, 2011 from http://www.asee.org/papers-and-publications/publications/college-profiles/2010-profile-engineering-statistics.pdf

Goyette, K.A., & Mullen, A.L. (2006). Who studies the arts and sciences? Social background and the choice and consequences of undergraduate field of study. *The Journal of Higher Education, 77*(3), 497-538.

Grose, T.K. (2006). A surprising shortage. *Prism, 15*(6).

Harris, C. (2008). VoIP companies need experienced engineers. *Dice.* Retrieved June 28, 2009 from http://career-resources.dice.com/job-technology/voip_companies_need_experienced_engineers.shtml

Hodgson, A., Farr, R., & Gindy, N. (2004a). Going, going, gone... the engineers of tomorrow. *Engineering Management, 14*(2), 24-27.

Hodgson, A., Farr, R., & Gindy, N. (2004b). Going, going, gone... the engineers of tomorrow. *Engineering Management, 14*(3), 30-33.

Hoffman, H.L., St. Louis, T. & Hoffman, J.L. (2010). Understanding the influence of parent engineers on the college major choice of their daughters. *Journal of Women and Minorities in Science and Engineering, 16*, 237-256.

IEEE. (2009). *Preparing the U.S. foundation for the future electric systems: A strong power and energy engineering workforce*. Retrieved June 15, 2009 from www.pserc.wisc.edu/.../workforce/US_Power_and_Energy_Collaborative_Action_Plan_April_2009.pdf

Ireland faces engineer shortage. (2001b, June). *IIE Solutions, 33*(3), 16.

Junior Engineering Technical Society. (2009). *Who we are*. Retrieved June 16, 2009, from http://www.jets.org/whoweare/index.cfm

Kuncel, N.R., Crede, M., & Thomas, L.L. (2005). The validity of self-reported grade point averages, class ranks, and test scores: A meta-analysis and review of the literature. *Review of Educational Research, 75*(1), 63-82.

Lent, R.W., & Brown, S.D. (2006). On conceptualizing and assessing social cognitive constructs in career research: A measurement guide. *Journal of Career Assessment, 14*(1), 12-35.

Lent, R.W., Brown, S.D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, *45*, 79-122.

Lent, R.W., Sheu, H-B., Schmidt, J., Brenner, B.R., Wilkins, G., Brown, S.D., et al. (2005). Social cognitive predictors of academic interests and goals in engineering: Utility for women and students at historically black universities. *Journal of Counseling Psychology*, *52*(1), 84-92.

Massachusetts Institute of Technology, Office of Engineering Outreach Programs. (2009). *Minority introduction to engineering and science*. Retrieved July 1, 2009, from http://web.mit.edu/mites/About.html

Merriman, J. (2008, June 3). Shortage of engineers plagues oil industry. *The New York Times*. Retrieved June 28, 2009, from http://www.nytimes.com/2008/06/03/business/worldbusiness/03iht-3rtroilskills.13427817.html?_r=1&scp=1&sq=Shortage%20of%20engineers%20plagues%20oil%20industry&st=cse

Michigan State University News. (2010, February 20). *Parents still major influence on child's decision to pursue science career*. Retrieved February 28, 2011, from http://news.msu.edu/story/7489/

Moore III, J. L. (2006). A qualitative investigation of African American males' career trajectory in engineering: Implications for teachers, school counselors, and parents. *Teachers College Record*, *108*(2), 246-266.

National Action Council for Minorities in Engineering. (2009). Retrieved June 26, 2009, from http://www.nacme.org

National Science Board. (2000). *Science and engineering indicators – 2000* (Publication No. NSB-00-1). Washington, DC: Government Printing Office.

National Science Board. (2004). *Science and Engineering Indicators 2004.* Two volumes. Arlington, VA: National Science Foundation (volume 1, NSB 04-1; volume 2, NSB 04-1A).

National Science Board. (November 19, 2007). *Moving forward to improve engineering education*. National Science Foundation. Retrieved March 1, 2010, from http://www.nsf.gov/pubs/2007/nsb07122/nsb07122.pdf

National Science Foundation. (2003). *Women, minorities, and persons with disabilities in science and engineering.* National Science Foundation, Arlington.

National Science Foundation. (2007). *Integrated postsecondary education data system, completions survey, 1998-2007*. National Science Foundation, Arlington.

National Employment Matrix. (2007). *Projections Data*. Retrieved June 30, 2009, from http://www.bls.gov/oco/ocos027.htm.

Nauta, M.A. & Epperson, D.L. (2003). A longitudinal examination of the social-cognitive model applied to high school girls' choices of nontraditional college majors and aspirations. *Journal of Counseling Psychology, 50*(4), 448-457.

Netherlands faces engineer shortage. (2001a, March). *IIE Solutions, 33*(6), 12.

Nicholls, G.M., Wolfe, H., Besterfield-Sacre, M., Shuman, L.J., & Larpkiattaworn, S. (2007). A method for indentifying variables for predicting STEM enrollment. *Journal for Engineering Education, 96*(1), 33-44.

North Carolina State University. (2009). *NC State University engineering summer programs*. Retrieved June 15, 2009, from http://www.engr.ncsu.edu/summerprograms/

Nuclear industry 'desperate' for engineers. (2004, mid-May Supp). *IEE Review*, 3.

Ohland, M.W., Sheppard, S.D., Lichtenstein, G., Eris, O., Chachra, D., & Layton, R.A. (2008). Persistence, engagement, and migration in engineering programs. *Journal of Engineering Education, 97*(3), 259-278.

Ojeda L. & Flores, L.Y. (2008). The influence of gender, generation level, parent's education level, and perceived barriers on the educational aspirations of Mexican American high school students. *The Career Development Quarterly, 57*, 84-95.

PayScale, Inc. (2010). *Best undergrad degrees by salary*. Retrieved May 17, 2010, from http://www.payscale.com/best-colleges/degrees.asp.

Peng, S. S., Wright, D., & Hill, S.T. (1995). *Understanding racial-ethnic differences in secondary school science and mathematics achievement*. U.S. Department of Education, National Center for Education Statistics.

Pennsylvania State University Cooperative Extension. (2008). *Overview of career development theory*. Retrieved January 21, 2010, from http://extension.psu.edu/workforce/Briefs/OverviewCareerDev%28Insert%29.pdf

Porter, C. (2010). *High school activities, characteristics, and influences survey*.

Potvin, G., Tai, R., & Sadler, P. (2009, June). *The difference between engineering and science students: Comparing backgrounds and high school experiences*. Paper presented at the meeting of the American Society for Engineering Education, Austin, TX.

Project Lead The Way. (2007-2008). *About PLTW*. Retrieved June 15, 2009, from http://www.pltw.org/About/About-Us.cfm

Project Lead The Way. (2010). *The PLTW network*. Retrieved May 2, 2011, from http://www.pltw.org/educators-administrators/pltw-network

Purdue School of Engineering and Technology. (2009). *Preparing outstanding women for engineering roles (power)*. Retrieved June 15, 2009, from http://www.engr.iupui.edu/power/

Rovito, R. (2007, November 9). Engineering more engineers. *The Business Journal*. Retrieved June 28, 2009, from http://milwaukee.bizjournals.com/milwaukee/stories/2007/11/12/story3.html

Sitaramiah, G. (2006, May 16). Energizing engineers: High schools try to interest more kids in a lucrative field that badly needs fresh talent. *Pioneer Press*. Retrieved June 28, 2009, from http://www.redorbit.com/news/education/506134/energizing_engineers_high_schools_try_to_interest_more_kids_in/index.html#

Smith, T.B. (2004). *Practicing multiculturalism: Affirming diversity in counseling and psychology*. Pearson Education, Inc.

South Carolina State Department of Education. (2011). *PACE Overview*. Retrieved May 1, 2011, from http://www.scteachers.org/cert/pace/overview.cfm

Staff. (2005). Engineers, scientists, skilled production workers missing in action. *Control Engineering, 4*(12).

Stewart, D.R. (2008, July 9). Governor signs bill for aero-engineers. *Tulsa World*. Retrieved June 29, 2009, from http://www.tulsaworld.com/business/article.aspx?articleID=20080709_45_E1_spancl945793

Summers, M.F., & Hrabowski, F.A. (2006). Preparing minority scientists and engineers. *Science, 311*(5769), 1870-1871.

Thomas, J. (2008, December 16). As need for nuclear engineers grows, Michigan program rated first. *America.gov*. Retrieved June 28, 2009, from http://www.america.gov/st/educ-english/2008/December/200812151143531CJsamohT0.3313867.html

TryEngineering. (n.d.). *About TryEngineering.org*. Retrieved June 27, 2009, from http://www.tryengineering.org/about.php

Tyson, W., Lee, R., Borman, K.M., & Hanson, M.A. (2007). Science, technology, engineering, and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk*, *12*(3), 243-270.

United States Department of Labor. (2007). *Occupational outlook handbook, 2008-09.* Retrieved May 18, 2009, from http://www.bls.gov/oco/ocos027.htm

United States Department of Labor. (n.d.). *Standard Occupational Classification*. Retrieved March 1, 2010, from http://www.bls.gov/soc/2010/soc170000.htm

U.S. Census Bureau. (2010). *American fact finder.* Retrieved November 11, 2010, from http://factfinder.census.gov/home/saff/main.html?_lang=en

Walmsley, A., Wilson, T. & Morgan, C. (2010). Influences on a college student's major: A developmental perspective. *Journal for the Liberal Arts and Sciences, 14*(2), 25-46.

Weiss, T. (2009). The 10 hardest jobs to fill in America. *Forbes*. Retrieved June 11, 2009, from http://www.forbes.com/2009/06/03/hard-jobs-fill-leadership-careers-employment.html

Wimberly, G.L. & Noeth, R.J. (2004). *Schools involving parents in early postsecondary planning.* (ACT Policy Report). ACT, Inc.

Women In Engineering ProActive Network. (2005). *About us.* Retrieved June 17, 2009, from http://www.wepan.org/displaycommon.cfm?an=4

York, E.A. (2008). Gender differences in the college and career aspirations of high school valedictorians, *Journal of Advanced Academics, 19*(4), 578-600.